V 12 1981

DOE/PE-0035

474-C-1

E 1.81:0035

COMPLETED

Macroeconomic Consequences of Natural Gas Decontrol

Appendix C to "A Study of Alternatives to the Natural Gas Policy Act of 1978"

November 1981

U.S. Department of Energy
Office of Policy, Planning and Analysis
Division of Energy Deregulation
Washington, D.C. 20585

This report has been reproduced directly from the best available copy.

Available from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161.

Price: Printed Copy A10
Microfiche A01

Codes are used for pricing all publications. The code is determined by the number of pages in the publication. Information pertaining to the pricing codes can be found in the current issues of the following publications, which are generally available in most libraries: *Energy Research Abstracts, (ERA); Government Reports Announcements* and Index (*GRA* and I); *Scientific and Technical Abstract Reports (STAR);* and publication, NTIS-PR-360 available from (NTIS) at the above address.

DOE/PE/0035
Dist. Category UC92, 92a & 92b

Macroeconomic Consequences of Natural Gas Decontrol

Appendix C to "A Study of Alternatives to the Natural Gas Policy Act of 1978"

November 1981

Prepared by:
ICF, Inc.
Washington, D.C. 20006
Under Contract No. AC01-81PE 70274

Scientific Time Sharing Corporation
MTSC Division
Rockville, MD 20852
Under Contract No. AC01-79PE 70046

Prepared for:
U.S. Department of Energy
Office of Policy, Planning and Analysis
Division of Energy Deregulation
Washington, D.C. 20585

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

A

Table of Contents

EXECUTIVE SUMMARY

I. INTRODUCTION

II. EFFECTS OF DECONTROL ON THE SUPPLY AND DEMAND SIDES OF THE ECONOMY

- A. Supply-Side Impacts
  1. Overview: Supply Side Effects and Real Potential Output
  2. Decontrol and Productivity in the Economy
  3. Effects on the Supply of Labor and Capital
  4. Summary of Supply Side Effects and Impacts on Potential GNP
- B. Demand-Side Impacts
  1. Analytical Approach: Theory, Models [illegible].
  2. The DRI and Wharton Macroeconomic Models
  3. Simulation Methods
  4. Demand Side Impacts: Consequences for Inflation, Output, and Unemployment
  5. Summary

III. CONCLUSIONS

Attachment 1: The Macroeconomic Effects of Natural Gas Price Decontrol, Dale Jorgensen, Associate

Attachment 2: The Economic Effects of Accelerated Decontrol Based on DRI Model Simulations, MTSC Division, Scientific Time Sharing Corporation

Attachment 3: The Macroeconomic Effects of Nature Gas Price Decontrol: Simulation Results From the Wharton and Industry Forecasting Model

EXECUTIVE SUMMARY

This report examines the various economic consequences of the decontrol of natural gas prices. It compares macroeconomic conditions arising under three alternative policy scenarios--full and immediate deregulation in 1982, phased decontrol by 1985, and deregulation in 1985 per the Natural Gas Policy Act of 1978.

ANALYTICAL APPROACH

1. Demand Side vs. Supply Side Effects

The approach used in this analysis distinguishes between the various effects of natural gas decontrol on the supply-side and demand-side of the economy. Supply-side effects refer to how alternative decontrol strategies could induce changes in the availability, productivity, and allocation of resources used to produce goods and services in the economy. Demand-side effects refer to how the direct and indirect price impacts of decontrol could affect the overall rate of inflation, unemployment and the level of total expenditures and economic output.

This distinction is important for two reasons. First, while adverse demand-side effects could arise in the short-term, changed decontrol policies ultimately would have permanent, structural effects on the supply-side of the economy. Second, the distinction between supply-and demand-side effects corresponds to a similar distinction between "actual" output (aggregate demand) and "potential" output (aggregate supply) effect. At any given time, changes in actual output need not correspond to changes in potential output. However, the long-term growth path of actual output (as well as lower rates of inflation and unemployment) depends on forces and events--including changes in public policies--that raise the underlying output potential of the economy.

2. Quantitative Assessment

Econometric models of the U.S. economy were used as part of this analysis to estimate quantitatively the direction, magnitude, and timing of the major effects. Based on an analysis of the effects of changed decontrol policies on gas prices, consumption, and supplies (as described in Appendix A), the macroeconomic simulations provide insights into the general equilibrium adjustments that would follow.

MAJOR FINDINGS

1. Potential Output Effects

A major finding of this analysis is that full decontrol would yield a net addition of $41.1 billion (1980 $) to potential output of the economy over the 1982-1995 period. Similarly, phased decontrol would increase potential output by $38.8 billion (1980 $). Underlying these results is a clear and distinctive pattern for both options: short-term costs followed--and eventually outweighed--by long-term benefits. Real potential output may fall immediately following decontrol, largely because of costs incurred by firms of adjusting to changes in the price and availability of gas. However, in later periods the efficiency gains, lower energy resource costs, and expanded supplies of factor inputs resulting from decontrol are estimated to raise the output potential of the economy.

2. Estimates of Inflation, Output and Unemployment Effects

Full and immediate decontrol deregulation may increase the rate of inflation, lower total real spending (real GNP), and raise the rate of unemployment. Estimates of inflation effects range from a 1.4 to 2.5 percentage point increase in the inflation rate (GNP deflator) in 1982. Full decontrol may also reduce total real output (GNP) by .4 percent or approximately $10.9 to $13 billion (1980 $) and increase the unemployment rate by .2 to .3 points annually during the first three years of decontrol.

The impacts of phased decontrol are likely to be smaller in magnitude and different in timing compared to full decontrol. The average annual impact on actual real GNP between 1982-84 is reduced by roughly $5.4 billion (1980 $); from $13.0 to $7.6 billion (1980 $). In addition, under phased decontrol the maximum impact on actual GNP occurs one year later (1984) compared to full decontrol. Impacts on inflation also follow different paths, corresponding to the distinctly different paths followed by gas prices between the two policy options. The maximum increase in inflation under phased decontrol is less than .1 points per year above current policy. Impacts on the unemployment rate also are small, ranging from 0 to .2% annually or 0 to 200,000 jobs per year.

It should be noted that there estimates represent only rough approximations on the direction and magnitudes of the effects of decontrol on inflation, real GNP and unemployment. The macroeconomic models used contain no explicit mechanisms for incorporating the economic efficiency and real resource effects of of decontrol. Major "off-line" changes are required to represent the beneficial effects of decontrol in these models.

I. INTRODUCTION

As have other energy policy initiatives, decontrol of natural gas prices will have significant short- and long-term effects on the U.S. economy. Gas and other kinds of energy play important roles in the manufacture and distribution of nearly all goods and services. Gas alone accounts for over one-fourth of all the energy consumed in the economy, and almost one-third of the energy consumed in the industrial sector.1/

Changes in the price and availability of gas under alternative decontrol strategies will have major direct and indirect impacts on individual incomes, consumption patterns, and production decisions of businesses. Households that use gas will face substantially different gas prices. This may lead to changes not only in the amount of gas they consume but also to changes in their consumption of other goods and services. Commercial, industrial, and electric utility users may alter production methods (the mix of capital, labor, and energy they use) in response to changes in gas prices and supplies. Decontrol may also transfer large amounts of wealth and income within the economy, particularly from gas users to gas producers.

This analysis examines the major implications of natural gas decontrol for overall economic performance. The conceptual approach adopted here distinguishes between the various effects decontrol would have on the supply-side and demand-side of the economy. This distinction is important because decontrol could affect very differently activities relating to aggregate supply--the potential output of goods and services--and activities relating to aggregate demand--the total expenditures for consumption, investment, government purchases, and net exports.

Econometric models of the U.S. economy were used to estimate the timing, direction, and magnitude of these effects. This analysis takes as given a set of partial equilibrium consequences of decontrol for gas prices, consumption, and supplies. The task is to understand the macroeconomic, general equilibrium adjustments that will follow.

1/ DOE, Energy Information Administration, Annual Report to Congress (1980). Example of industrial sectors for which gas is a primary or major fuel include: chemicals, petroleum refinery, stone and clay, glass, textiles, food processing, and iron and steel.

II. EFFECTS OF DECONTROL ON THE SUPPLY AND DEMAND SIDES OF THE ECONOMY

Our economic system consists of a "supply-side"--firms which produce goods and services--and a "demand side"--businesses, households, and government--which consume them. This chapter describes the effect on both sides of the economy of gas decontrol.

On the supply-side, decontrol may have permanent, structural impacts. Changes in the price and availability of gas are likely to have direct consequences for the overall cost, level, and mix of energy use. These changes would induce shifts in the allocation of real resources used to produce goods and services in the economy. On the demand-side, decontrol may dampen total spending and output because of its direct and indirect effects on prices. However, most of the demand-side impacts should be temporary, diminishing steadily as the economy adjusts to the changes in gas prices resulting from decontrol.

A. SUPPLY-SIDE IMPACTS

Accelerated decontrol of natural gas prices poses the potential for significant structural changes in the supply-side of our economy. Accompanying decontrol would be changes in the amount of real resources the economy has available and in the way it uses them to produce final goods and services for households and businesses. Many of the changes would be beneficial, originating in part from an anticipated positive impact on investment, and hence, the capital stock of the economy. Other positive impacts would stem from the favorable effects of decontrol on the total level and composition of our energy supplies. Decontrol will also have important indirect effects on the supplies of other factor inputs and overall factor productivity. Some of these impacts may be negative, since decontrol would raise the cost of energy to many producing sectors.

This section describes the supply-side effects of natural gas decontrol, together with estimates of their timing and magnitudes. Specifically, it compares overall economic performance under current decontrol policy (Natural Gas Policy Act) to that arising from:

- Full and immediate deregulation in 1982
- Phased decontrol by 1985.

Most of this analysis is based on macroeconomic simulations of accelerated natural gas decontrol using the Hudson-Jorgensen Dynamic General Equilibrium Model (DGEM).[2] Analysis was undertaken with this model because, unlike other macroeconomic models, DGEM incorporates important supply-side mechanisms in the economy. Detailed information on changes in gas market conditions under accelerated decontrol was introduced directly into DGEM. In response to these changes, DGEM simulates how economic growth, energy-economy linkages, and the structure of the economy overall would in turn be affected.

1. Overview: Supply Side Effects and Real Potential Output

The supply-side effects of decontrol correspond to changes in potential real output (potential GNP), the measure of the economy's aggregate supply capability.[3] Potential output depends both on the supply of real economic resources (capital, labor, energy, and materials) and the productivity with which they can be used. Natural gas decontrol--by enhancing the productivity and increasing the availability of our nation's economic resources--provides the opportunity to achieve real gains in the output potential of the economy.

This analysis focuses on the real potential output effects of decontrol. The short-term changes in actual output (real GNP) and the associated effects on unemployment and inflation may also be important although temporary, and they are examined elsewhere in this report. On the other hand, decontrol would involve permanent changes in the output potential of the economy. Analysis of these effects, more than the demand-side effects, provides the principal basis for deciding whether overall economic performance could be improved by decontrolling natural gas. Indeed, while actual and potential output can change independently in the short-term, in the long-term higher levels of actual output (as well as lower levels of inflation and unemployment) can only be achieved by raising the underlying output potential of the economy.

---

[2] Detailed documentation of this analysis is provided in Attachment I.

[3] "Potential real GNP" can be understood as the volume of real gross national product that the economy could provide if all resources (capital, labor, materials) were fully utilized. This analysis is not concerned with the absolute level of potential GNP but rather the change in potential GNP.

Since DGEM incorporates the determinants of potential output and economic growth, estimates of the GNP impacts from this model can be interpreted as impacts on potential output.[4] Based on the DGEM simulations, gas decontrol is estimated to yield a net economic benefit over the 1982-1995 period. A summary of the annual impacts on real potential GNP is shown in Table 1. The cumulative gain (1982-1995) in potential GNP is estimated to be $40.7 billion (1980 $)[5] for full decontrol and $37.8 billion for phased decontrol.[6]

However, the clear and distinctive time pattern of the effects of natural gas decontrol is equally as important as the overall impact. Stated simply, decontrol results in short-term costs followed--and eventually outweighed--by long-term benefits. Potential output losses average $6.9 billion for the three years immediately following full decontrol and $5.4 billion for phased decontrol. The average potential output loss is slightly less under phased decontrol, largely because the gas price increases are not as sharp during this period. From 1985 onward, the effects of decontrol turn positive in both policy cases, as real output and income are higher compared to current policy.

The causal mechanisms that underlie these impacts are complex and change over time. As described below, they primarily involve adjustments in productivity conditions and changes in supplies of factor inputs.

---

[4] More precisely, DGEM can be characterized as a long term general equilibrium model. In DGEM, desired expenditures (aggregate demand) is always consistent with what is achieveable from production, or the supply and capacity potentials of the economy. This feature ensures that the estimates from DGEM refer to the effects of decontrol on potential rather than actual output.

[5] All estimates are provided in constant 1980 dollars to be consistent with other elements of the decontrol study.

[6] Using a discount rate of six percent, the net present values of these gains are $17.8 for full decontrol and $18.1 billion for phased decontrol. Economists tend to disagree on the appropriate discount rate for future real GNP benefits or costs. This rate was chosen to be consistent with other segments of the natural gas decontrol study.

TABLE 1

IMPACTS OF DECONTROL ON REAL POTENTIAL GNP
(Changes from Current Policy)

	Full Decontrol		Phased Decontrol	
	1980 $ billion	% Change	1980 $billion	% Change
1982	- 8.5	-0.31	- 3.4	-0.12
1983	- 6.7	-0.24	- 6.2	-0.22
1984	- 5.5	-0.19	- 6.7	-0.23
1985	3.9	0.13	3.9	0.13
1986	5.1	0.17	5.3	0.18
1987	5.7	0.18	5.1	0.16
1988	5.1	0.16	4.6	0.14
1989	5.7	0.17	5.1	0.15
1990	6.0	0.18	5.3	0.16
1991	5.3	0.15	4.6	0.13
1992	6.0	0.17	5.3	0.15
1993	6.6	0.18	4.3	0.11
1994	6.0	0.16	5.3	0.14
1995	6.0	0.15	5.3	0.14
Total, 1982-1995	40.7		37.8	
NPV @ 6%	17.8		18.1	

2. Decontrol and Productivity in the Economy

One key measure of economic performance is productivity--the amount of output obtainable from a fixed set of resources, or "factor inputs." Productivity conditions reflect the allocation of resources in our economy and the manner (or intensity) in which they are used. The productivity consequences of decontrol in particular depend on the reallocation of resources devoted to energy supply activities in the economy, as measured by changes in the "real resource costs" of energy, and changes in energy costs and input patterns in non-energy sectors.

Real Resource Costs

"Real resource costs" refer generally to the amount of real economic resources needed to bring forth the amount of energy used in the economy. For gas and oil,[7] these costs include:

- the minimum revenues required to cover the production costs of domestic gas,
- the cost of imported gas,
- the cost of oil consumed in the industrial and electric utility sectors of the economy.

Gas decontrol would lower total real resource costs in several important ways.

Real Resource Benefits from Efficiency Improvements

Higher energy productivity permitted by efficiency improvements in the production and allocation of gas would lower real resource costs. Existing policies that provide for price controls, administered curtailments, and end-use restrictions often prevent gas from being supplied and allocated in the most economically efficient and productive manner. This results in real losses to gas producers, users, and the economy in general.

Decontrol of natural gas prices will reduce inefficiencies in gas supplies. Wellhead price controls provide a major disincentive for the production of relatively inexpensive domestic gas. More expensive domestic and imported supplies must be used to supplement price-controlled gas. However, this mix of supplies is inefficient. Real economic losses occur because the costs of supplemental gas often exceed the costs of the gas that would be produced first in the absence of price controls. Under wellhead price decontrol, producers would have the incentive to produce low cost gas rather than more expensive supplemental gas. Correcting the inefficient mix of gas supplies would yield real resource savings to the economy as a whole. Resources previously used in gas production would be released to other sectors of the economy.

---

[7] That is, oil that is fungible with natural gas.

Decontrol will also correct inefficiencies in gas allocation. Under curtailment and other demand restrictions, gas is sometimes supplied to some users rather than others willing to pay more, forcing the latter to switch to more costly fuels. This represents an important cost to the economy of controls on gas allocation. Removal of these restrictions would permit gas to be allocated more efficiently. Allocation improvements, along with increased gas availability through conservation and production, would enable some producers of goods and services to substitute gas for more expensive fuels, especially oil. Substitutions to less expensive fuels would reduce production costs for these users, enabling them to lower the prices of the goods and services they produce.

In sum, improvements in the efficiency of gas production and allocation would raise the productivity of energy. Less costly energy inputs (as measured by costs per Btu) would be required per unit of final output. The more productive use of energy supplies could be viewed as resource savings--fewer resources required to satisfy the energy requirements of the economy.

Real Resource Benefits from Reduced Oil Imports

A key benefit of the production and allocation efficiency improvements is that natural gas would displace foreign oil. Prices that reflect the marginal cost of natural gas would provide the incentive for existing users to conserve gas and for gas producers to increase exploration, development, and production activities. Increased Btu's from conservation and expanded gas production would replace Btu's from imported oil. Since the additional costs of the expanded gas production are likely to be less than the world oil price, substitutions of gas for imported oil would result in lower resource costs for a given level of energy than under controlled prices. Real resource savings would occur if the amount of economic resources needed to produce gas domestically were less than the amount needed to produce the export goods that must be exchanged for imported oil. Reductions in the costs of imported energy would leave more resources available for domestic consumption and investment. Overall economic productivity would increase, raising the potential level of real economic output and national income.

Table 2 displays the timing and magnitudes of the real resource effects for full and phased decontrol as estimated by DOE. These estimates include the favorable effects (i.e., cost savings) due to enhanced efficiency in the gas market and those due to lower levels of oil imports. Throughout the period, full and phased decontrol both result in lower real resource costs to the economy compared to current policy. During the first three years, additional resources are absorbed by the gas producing sector. However, the additional gas produced displaces petroleum in the electric utility and industrial sectors, securing an estimated net real resource savings to the economy from $10.5 to $19.8 billion between 1982-1984, depending on the policy chosen. Real resource savings would be higher for full decontrol compared to phased decontrol because more gas would become available in this period, displacing larger volumes of imported oil.

From 1985 onward, the real resource effect are nearly identical between the policy cases. Because conventional gas supplies are depleted earlier under both accelerated decontrol options, fewer economic resources are likely to be expended on gas production. Oil consumption (and hence oil expenses) rises to meet energy requirements among oil/gas fungible users in the electric utility and industrial sectors. However, compared to current policy, this mix of energy supplies is still more efficient. Real resource savings are sustained throughout this period under accelerated decontrol.

In total, full decontrol results in a net real resource benefit of $43.2 billion and phased decontrol $35.5 billion between 1982-1995.[8/] The resource shifts accompanying these savings would serve to raise the overall productivity and output potential in the economy.

Other Productivity Consequences

Natural gas decontrol is likely to have a mixture of other productivity effects. While productivity benefits would result from lower resource cost for energy, changes in gas prices alone under decontrol could also affect productivity conditions. Capital and labor productivity in the non-energy producing sectors of the economy in particular may be affected.

[8/] The net present value of these gains is $33.1 billion for full decontrol and $25.6 billion for phased decontrol (using a discount rate of six percent).

TABLE 2

TOTAL REAL RESOURCE EFFECTS OF DECONTROL:
Change from Current Policy
(Billions of 1972 $)

	Full Decontrol[a]			Phased Decontrol[a]		
	Gas Costs	Oil Expense	Net Resource Effect	Gas Costs	Oil Expense	Net Resource Effect
1982	.5	-6.1	- 5.7	.3	-1.2	- 0.9
1983	.2	-7.1	- 6.9	1.3	-4.7	- 3.3
1984	.8	-8.0	- 7.2	1.6	-7.7	- 6.1
1985	- 4.4	-0.8	- 5.2	- 5.4	0.1	- 5.3
1986	- 5.0	-0.6	- 4.4	- 6.3	1.2	- 5.1
1987	- 4.5	2.1	- 2.4	- 4.8	2.3	- 2.5
1988	- 3.7	1.6	- 2.1	- 3.9	1.7	- 2.2
1989	- 4.2	2.3	- 1.8	- 4.2	2.2	- 2.0
1990	- 4.3	2.7	- 1.6	- 4.2	2.5	- 1.7
1991	- 3.6	2.0	- 1.5	- 3.4	1.8	- 1.6
1992	- 4.1	2.8	- 1.3	- 3.9	2.5	- 1.4
1993	- 3.2	2.0	- 1.2	- 2.8	1.6	- 1.3
1994	- 4.3	3.3	- 1.0	- 3.9	2.8	- 1.1
1995	- 4.2	3.3	- .9	- 3.8	2.8	- 1.0
Totals	-44.1	0.7	-43.2	-43.4	7.9	-35.5
NPV @ 6%	-26.4	-6.9	-33.7	-26.2	.5	-25.6

---

a/ Numbers may not add due to independent rounding.

DOE's analysis shows that accelerated gas decontrol leads to higher prices to natural gas users. Higher prices will result in higher costs for the energy that firms use, unless they faced restrictions on the quantity of gas available to them before decontrol.

Price Effects on Input Patterns

If faced with higher energy costs, firms may respond by reducing the gas and energy intensity of their production. Less energy input per unit of output may involve a productivity cost. In addition, to maintain previous levels of output, more capital and labor inputs would have to be used. Since capital and labor are not perfect substitutes for energy, this would involve a reduction in the marginal productivity of capital and labor, particularly in the non-energy production sectors of the economy. Total productivity and output may decline in some sectors as energy costs increase relative to other factor inputs. However, these declines may be offset by productivity and output gains in the other sectors in the economy that would face relatively lower prices or increased availability of gas under decontrol.

Analysis using DGEM suggests that the price effects of decontrol may result in slightly higher shares of capital and labor inputs per dollar of final output. This occurs mainly between 1982 and 1984, when the changes in gas prices are greatest. The full decontrol option, for example, is estimated to raise on average the capital share of total input by .4 percent (from about 14.08 to 14.14 percent) and the labor share by .2 percent (from about 26.89 to 26.94 percent) and lower the energy share by four percent (from 5.79 to 5.55). The magnitude of these effects for phased decontrol are smaller, since gas prices rise less under that option.

Reduction in capital and labor productivity would involve an output cost: increases in the labor and capital intensity of production would correspond to a reduction in the amount of output obtainable from each unit of labor and capital input. The DGEM analysis suggests that short-term losses in real potential output would arise due to these productivity effects of decontrol. However, since the changes in labor and capital productivity are small and only temporary, so too are the corresponding changes in total productivity and output.

Price Effects on Structure of Final Demands

Increases in gas prices and costs could also alter overall productivity conditions if final demands shift away from gas and gas-intensive goods and services to those sectors which experience smaller price increases. One possibility is that price-induced demand shifts toward less productive sectors would involve productivity losses for the economy as a whole. Likewise, shifts away from less productive sectors would yield productivity benefits. The net effects are not clear, however, since changes in total productivity in the economy depend on changes in marginal productivities in specific sectors. If different sectors do not have different productivity levels on the margin, then shifts in demands among sectors need not have any effects on overall productivity. Even if marginal productivities do differ significantly between sectors, the effects on productivity due solely to shifts in final demands caused by decontrol are likely to be very small. In the DGEM analysis, these effects contribute very little to the change in productivity conditions between 1982-1995.

3. Effects on the Supply of Labor and Capital

Labor and capital are two basic inputs into the production process. Increases in the supplies of capital and labor permit higher levels of economic output. The manner in which each is affected by decontrol thus may have important consequences for total economic performance.

Capital Supply Effects

Investment outlays are the principal determinant of the supply of capital in the economy. Changes in the level of investment induced by accelerated decontrol will depend mainly on whether more (or less) investment funds, or savings, become available and on any changes in the size of the government deficit. If savings increase because of the wealth transfer effects of decontrol,[9] investment outlays and hence, the capital stock of the economy would increase. However, savings could also fall due to the effects of decontrol on the labor supply and higher prices.[10] If the government deficit declines due to, say, an increase in tax receipts from gas producers, less "crowding out" of investment will occur. Less income is transferred to government to finance the public debt, making more available for investment.

---

[9] Total savings would increase if decontrol induces a transfer of wealth and income from those with a high propensity to spend (consume) to those with a high propensity to save.

[10] Earned incomes would be lower because individuals are working less. Lower total incomes and higher nominal consumption outlays would result in lower level of private savings.

Table 3 compares the impact of full and phased decontrol on real investment and the supply of capital. This table shows that decontrol is estimated to exert a positive influence on the supply of capital from 1983 onward. Capital availability under decontrol exceeds that estimated under the current policy scenario in every year.

Under full and phased decontrol, increases in the supply of capital between 1983-1985 are due largely to higher levels of private savings. During the three years following full decontrol, for example, higher dividends and retained earnings in the gas supply sector and increases in other capital income combine to offset an estimated $13 billion annual rise in nominal consumption outlays, resulting in an average annual increase of $34 billion in nominal private savings. A reduction in the government deficit also occurs during this period largely because of increased tax collection from gas producers. This, together with the increase in savings, raises real investment by approximately $15 billion, or an average of three percent, each year. In the phased decontrol case, an increase in real investment averaging roughly two percent each year arises through similar mechanisms.

TABLE 3

Impact of Decontrol on
Investment and Capital Supply
(Percentage Change from Current Policy)

	Full Decontrol:		Phased Decontrol:	
Year	Investment	Capital Supply	Investment	Capital Supply
1982	3.81%	0.00[a]	1.53%	0.00[a]
1983	3.28	0.32	2.40	0.13
1984	3.35	0.57	3.22	0.32
1985	0.41	0.79	0.50	0.56
1986	0.40	0.76	0.51	0.55
1987	0.31	0.72	0.34	0.54
1988	0.21	0.68	0.22	0.52
1989	0.20	0.64	0.21	0.49
1990	0.16	0.60	0.17	0.46
1991	0.11	0.56	0.11	0.44
1992	0.12	0.52	0.11	0.41
1993	0.03	0.48	0.05	0.38
1994	0.11	0.44	0.09	0.35
1995	0.07	0.41	0.05	0.32

---

a/ Capital supply in DGEM is fixed at the beginning of the year.

The continuing effects of decontrol on prices, savings, and the government deficit contribute to sustained increases in real investment from 1985 onward. While nominal levels of savings and the deficit tend to vary in magnitude and direction during this period, prices for capital goods are sufficiently lowered to permit a rise in real investment expenditures in every year.

The greater availability of capital resulting from the favorable impacts of full or phased decontrol on investment promotes an expansion in the productive capacity of the economy. Indeed, the rise in capital availability is the principal mechanism that reduces the early economic costs and secures the long-term economic benefit of accelerated decontrol.

Labor Supply Effects

The major factors affecting the supply of labor[11] in the long-run are wealth, capital income, consumption prices, and wage rates. As specified in DGEM increases in wealth and rates of return may tend to reduce labor supply if some individuals are encouraged to consume more leisure, i.e. work fewer hours. Labor supply may be stimulated if higher consumption prices (relative to wage rates) induce other individuals to work more hours to maintain a desired level of real consumption.

Through these mechanisms, full or phased decontrol of natural gas could affect the supply of labor in the long-term. Wealth, capital incomes, and consumer prices are all likely to increase because of gas decontrol. The price effects of decontrol and the transfer of income from gas-users to producers may raise the value of wealth and capital income. Higher output prices may result from higher gas costs to producers of goods and services. But because wealth, capital income and prices affect labor supply in opposite ways, the overall impact on labor depends on the relative magnitude of each factor. In fact the DGEM analysis of both options shows that the magnitudes of the net labor supply effects are not large between 1982-95. This implies that the wealth/capital income effects and the price effects on labor supply tend to offset each other throughout this period.

---

[11] In this context, the "supply of labor" refers to the total amount of labor services available in the economy. It consists of two components: (1) the number of individuals able and willing to work; (2) the average number of hours each individual is willing to work.

4. Summary of Supply-Side Effects and Impacts on Potential GNP

This section assembles and summarizes the supply side adjustments induced by decontrol and points to their separate effects on potential GNP. Some of the changes induced by accelerated decontrol--the investment and real resource impacts, for example--will unambiguously exert a positive influence on the economy. However, the impacts of other changes are less clear.

Effects on Real Potential Output

Expanded supplies of factor inputs and higher levels of factor productivity raise potential real output--reduced factor supplies and diminished productivity lower it. Tables 4a (full decontrol) and 4b (phased decontrol) decomposes the real GNP effects from decontrol into the changes due to factor inputs and changes due to productivity conditions. As revealed in both tables, the short-term costs of accelerated decontrol are due to productivity impacts. The long-term benefits are due to factor input effects, particularly increases in the supply of capital.

The separate impacts of factor input changes on real GNP are also displayed in Table 4. The reduction in labor supply that occurs during all years for both options causes a reduction in real GNP, although the magnitudes of these effects are very small. These impacts, however, are more than offset by the positive effects on real GNP of sustained increases in investment occuring throughout the 1983-1995 period. The impact of full decontrol on investment raises potential GNP by a maximum of 28% in 1985, with the effects remaining positive through the 1983-1995 period. Under phased decontrol, the maximum and average impacts of investment on potential GNP are slightly smaller. This analysis of the factor input changes shows that the investment-capital effect dominates the factor input response to accelerated decontrol. Indeed, the capital supply effect is the major reason for the long-term beneficial effects of decontrol and for the overall positive benefit from this policy change.

Several mechanisms and effects are important in explaining the productivity impacts of decontrol on real GNP. Higher energy prices, and so less energy input and more capital and labor input in non-energy production, lowers total factor productivity and leads to a temporary loss in output. This is the most important mechanism underlying the negative impacts on real GNP during the period immediately following decontrol. On

Table 4a - Full Decontrol

Principal Components of Potential GNP Effects

	Total GNP Impact	Productivity Impacts	Factor Input Impact: Total	Factor Input Impact: Capital Component	Factor Input Impact: Labor Component
1982	-0.31	-0.32	0.01	0.00[a/]	-0.01
1983	-0.24	-0.34	0.10	0.12	-0.02
1984	-0.19	-0.37	0.18	0.21	-0.03
1985	0.13	-0.08	0.21	0.28	-0.07
1986	0.17	-0.04	0.21	0.27	-0.06
1987	0.18	-0.03	0.21	0.26	-0.05
1988	0.16	-0.02	0.18	0.24	-0.06
1989	0.17	-0.01	0.18	0.23	-0.05
1990	0.18	0.00	0.18	0.22	-0.04
1991	0.15	-0.01	0.16	0.20	-0.04
1992	0.17	0.02	0.15	0.19	-0.04
1993	0.18	0.05	0.13	0.17	-0.04
1994	0.16	0.04	0.12	0.16	-0.04
1995	0.15	0.04	0.11	0.15	-0.04

EXPLANATORY NOTE: The "Total GNP Impact" (Column 1) is the sum of the "Productivity Impacts" (Column 2) and the "Factor Input/Impact: Total" (Column 3). The "Factor Input/Impact: Total" consists of a "Capital Component" (Column 4) and a "Labor Component" (Column 5).

[a/] Capital stock in DGEM is fixed at the beginning of the year.

Table 4b - Phased Decontrol

Principal Components of Potential GNP Effects

			Factor Input Impact:		
	Total GNP Impact	Productivity Impacts	Total	Capital Component	Labor Component
1982	-0.12	-0.13	0.01	0.00[a]	-0.01
1983	-0.22	-0.26	0.04	0.05	-0.01
1984	-0.23	-0.34	0.11	0.12	-0.01
1985	0.13	-0.02	0.15	0.20	0.05
1986	0.18	0.02	0.16	0.20	-0.04
1987	0.16	0.01	0.15	0.19	-0.04
1988	0.14	-0.01	0.15	0.19	-0.04
1989	0.15	0.01	0.14	0.18	-0.04
1990	0.16	0.03	0.13	0.17	-0.04
1991	0.13	0.01	0.12	0.16	-0.04
1992	0.15	0.04	0.11	0.15	-0.04
1993	0.11	0.01	0.10	0.14	-0.04
1994	0.14	0.04	0.10	0.13	-0.03
1995	0.13	0.04	0.09	0.12	-0.03

EXPLANATORY NOTE: The "Total GNP Impact" (Column 1) is the sum of the "Productivity Impacts" (Column 2) and the "Factor Input/Impact: Total" (Column 3). The "Factor Input/Impact: Total" consists of a "Capital Component" (Column 4) and a "Labor Component" (Column 5).

[a] Capital stock in DGEM is fixed at the beginning of the year.

the other hand, changes induced by accelerated decontrol in domestic energy supply and import-export effects exert a positive influence on productivity and the output potential of the economy. These productivity and output gains are sustained throughout most years between 1982-1995 and tend to offset the negative productivity effects due to higher gas prices. On balance, under full decontrol the adverse productivity effects on potential GNP are small and eventually yield to benefits from in the early 1990's. The productivity effects on potential output under phased decontrol are even smaller between 1982-85 and also turn positive earlier, mainly because the smaller and less abrupt increased gas prices causes smaller adjustments in factor-input patterns.

B. DEMAND SIDE IMPACTS

Activities on the demand-side of the economy consist of expenditures by households on final goods and services, investment expenditures by businesses, government purchases, and net exports to foreign countries. The demand-side impacts of accelerated decontrol will depend mainly on how the key determinants of the levels of these activities--incomes, aggregate prices, and interest rates--are affected by changes in natural gas prices.

Since accelerated decontrol will only result in temporary (although substantial) increases in gas prices, the price, income and interest rate effects of these increases and their effects on aggregate demand should also be temporary. Still, analysis of these effects is central to understanding the ways in which accelerated decontrol could affect the rate of inflation, real GNP, and levels of unemployment in the short-term.

1. Analytical Approach: Theory, Models, and Limitations

Macroeconomic theory provides a conceptual framework for understanding the major mechanisms underlying adjustments in aggregate demand. Econometric models incorporating macroeconomic theory, such as those developed by Data Resources, Inc. (DRI), Wharton, and Chase Econometrics, are available to assess quantitatively the effects of policy changes and other external events on economic activity. An annual version of the DRI quarterly model and the Wharton Annual and Industry Forecasting Model were used for this analysis.

The estimates and analysis presented here should be understood with care. While the DRI and Wharton models are well-known and widely-used macroeconomic forecasting tools, both models have shortcomings that limit their usefulness for this particular analysis. Neither the DRI nor the Wharton nor any other large-scale forecasting model was designed specifically to estimate the impacts of accelerated decontrol on the economy. If they had been, their structures might have been different, and they then might provide different results. Indeed, the structures of the models are not suited to incorporate many of the major effects of this policy change, particularly the economic efficiency and real resource benefits from decontrol. Major "off-line" adjustments must be made to incorporate these effects into the models. The emphasis placed in these models on short-term demand side rather than long-term supply-side relationships may further complicate this problem.

For these reasons, estimates provided by the DRI and Wharton model may miss or overstate the actual demand-side impacts of decontrol on the economy. They should be viewed as only rough estimates of the directions and orders-of-magnitude of these impacts. As such, the DRI and Wharton simulations contribute to--but do not determine--our analysis of how inflation, unemployment, and output may be affected in the short-term by gas decontrol.

2. The DRI and Wharton Macroeconomic Models

Both the DRI and the Wharton models incorporate aggregate demand concepts, making them useful for short-term (one to three years) forecasting and policy analysis.[12] In each model the major determinant of economic activity in the short-term is specified to be aggregate demand. However, the two models are by no means identical. The DRI model is based on quarterly changes in economic activity while the Wharton system is based on annual changes. More important, the Wharton model contains an interindustry input/output system, with relationships based on flexible coefficients, to explain industrial output and prices. In contrast, the DRI model employs a fixed-coefficient input/output framework. The Wharton model also contains greater detail on the supplies, prices, and demands of factor inputs (capital, labor, energy, materials), whereas the DRI model contains a much greater range of financial variables as determinants of consumption and investment expenditures. The features that differentiate the DRI and Wharton models permit analyses through different approaches. Each has the potential of incorporating different factors which may be important in understanding the short-term, demand-side impacts of decontrol.

---

[12] U.S. Dept. of Energy, Office of Policy, Planning and Analysis, Interrelatinships of Energy and the Economy: A Supplement to the National Energy Policy Plan, June 1981, p. 7-8. For this analysis, the DRI and Wharton models were simulated to 1990. However, because these models are short-term oriented, the estimates provided by them for periods beyond three years should be heavily discounted.

3. Simulation Methods

Simulating the macroeconomic effects of decontrol with the DRI and Wharton model involves adjusting the values of gas and other energy prices, demand, and supply variables in these models to make them consistent with DOE forecasts. As with the DGEM analysis, values of these variables corresponding to three policy cases: (full deregulation in 1982, phased decontrol by 1985 and current policy) were introduced explicitly into the DRI[13/] and Wharton models.[14/]

While a large number of changes were in each model, the adjustments by no means should be considered complete. For example, the DRI model does not consider explicitly the cost and quantity of gas consumed in the industrial and commercial sectors. Likewise, the Wharton model does not contain separate variables for commercial, industrial, or electric utility gas prices. Both models also do not differentiate between inter- and intrastate gas markets.

As indicated before, neither the DRI nor the Wharton model can directly incorporate the important effects of decontrol on economic efficiency and real resource costs. In these simulations, however, adjustments were made to each model in an attempt to capture these effects. In the DRI simulations, changes corresponding to the real resource effects of natural

---

[13/] For this analysis, the "OPTIMLONG2006" version of the DRI model was used. OPTIMLONG2006 is a DRI-developed long-term forecast of the economy incorporating economic assumptions and policy changes that are generally consistent with President Reagan's Program for Economic Recovery.

[14/] For details of these analyses, see Attachment II (DRI Model) and Attachment III (Wharton Model).

gas decontrol (see Table 2) were made to the potential GNP variable,[15] which is a measure of the amount of output achievable if labor were fully employed. The basis for making this change is that decontrol, by increasing the real energy resources available for production, increases aggregate production capacity. In the Wharton simulations, changes were made in the interindustry input/output matrix to reflect the potential amount of fuel switching from oil to less-expensive gas that might occur under accelerated gas decontrol.

These changes in the DRI and Wharton models tend to produce estimates of real GNP, employment, and inflation that are less negative (or more positive) than if no changes were made. However, the adjustments to account for the real resource effects of decontrol admittedly are imperfect and the theoretical basis for making them is very tentative.

4. Demand-Side Impacts: Consequences for Inflation, Output, and Unemployment

The DRI and Wharton simulations provide estimates of the range of possible impacts decontrol might have on the economy during the short term. This section describes these impacts, their estimated magnitudes, and the mechanisms specified in DRI and Wharton that explain why they might occur. Overall, natural gas decontrol is forecast by both models to have negative consequences on economic activity in the short-term, including reduced levels of real GNP, higher rates of inflation, and higher levels of unemployment. However, the estimated magnitudes of the effects are not large and tend to diminish over time.

Impacts on Inflation

In the years 1982 through 1984, higher prices for natural gas under decontrol can have significant and immediate impacts on inflation, as measured by increases in the Consumer Price Index (CPI) and GNP deflator. Higher prices for natural gas could affect the inflation rate in several ways. First, any increases in retail residential prices would be reflected directly in the CPI. Natural gas purchases account for about

---

15/ This should be distinguished from the potential GNP concept contained in the DGEM analysis. In contrast to DRI, potential GNP in DGEM depends not only on the supplies of factor input but also on the productivity with which those inputs can be used.

1.3 percent of the basket of goods and services used to calculate this index. Second, prices of goods and services directly and indirectly produced from gas could also rise, to the extent that gas-using producers are able to pass through higher gas costs to their customers. However, prices for some goods and services could conceivably decline under decontrol. The economic efficiency and real resource benefits of this policy could be reflected by lower production costs--and hence lower prices--for products of some sectors. In addition, the Administration's tight monetary policies may inhibit inflationary pressures initiated or exacerbated by the increases in gas prices. Nevertheless, given the general downward "stickiness" of prices in our economy in the short term, higher prices for natural gas under decontrol would tend to raise the overall price level in the short-term.

These mechanisms underlie the estimates provided by the DRI and Wharton models of the inflationary impacts of accelerated decontrol. The rates of change in the GNP deflator on the CPI (Table 5) illustrate the year-to-year effects of decontrol on the rate of inflation.

Both simulations show that most of the overall price level impacts of full and immediate decontrol would occur during the first year. In that year, decontrol is estimated to add from 1.5 to 2.4 points to the change in the GNP deflator. The inflationary impacts of full decontrol subside substantially in 1983, and in the DRI simulation have practically disappeared by the third year. The only significant difference between the estimates provided by the two simulations for full decontrol occurs in 1982, when the Wharton forecast of the impacts on the GNP deflator and CPI are approximately one percentage point higher than those estimated by the DRI model. This can be explained by the tendency of the Wharton model to pass through immediately all cost changes to final product prices. In DRI, the pass-through of increased costs is spread over a larger period of time.

The inflation effects of phased decontrol are smaller in magnitude and different in timing compared to full decontrol. Under this option, the average annual impact on inflation is lowered slightly (.1 percentage point), and the peak impact is reduced by roughly .6 percentage points. The inflation effects also follow different paths, with less "shock" estimated to occur in 1982 under phased decontrol. These differences correspond to distinctly different paths followed by gas prices between the two decontrol policies.

A key point in interpreting these results is that both models will eventually pass through the *entire* increase in gas costs to consumers in the form of higher final output prices. This feature of the models, however, may cause them to *overstate* the inflationary impacts of accelerated decontrol. In the actual economy, competition in product markets and demand responsiveness to changes in prices could discourage producers from passing through the entire gas price increase to consumers. The ability of competitive forces in specific markets to limit the pass-through of higher costs is not directly captured by either model.

TABLE 5

Inflation Impacts of Accelerated Decontrol:
% Rate of Change--GNP Deflator

	Current Policy:		Full Decontrol:[a]		Phased Decontrol[a]
	DRI	Wharton	DRI	Wharton	DRI[b]
1982	8.4	8.2	1.4	2.51	0.2
1983	7.2	7.7	0.7	.4	0.8
1984	5.9	7.9	0.1	0.2	0.8

% Rate of Change--Consumer Price Index
(CPI--All Urban Consumers)

	Current Policy:		Full Decontrol:[a]		Phased Decontrol[a]
	DRI	Wharton	DRI	Wharton	DRI[b]
1982	7.9	7.7	1.5	2.6	.2
1983	6.6	7.7	0.8	0.2	.8
1984	5.3	7.6	0.1	0.1	1.0

---

a/ Percentage point change from current policy.

b/ The inflation effects of phased decontrol were simulated only with the DRI model.

Impacts on Output

Decontrol may tend to reduce actual output (real GNP) in the short-run through the effects it might have on the overall price level. If accommodating monetary policies are not pursued, any increases in the price level may tend to reduce real incomes and increase interest rates relative to current policy conditions.[16] These effects, in turn, may serve to lower consumer spending and investment outlays.

The tendency of inflation to reduce real incomes explains how the price effects of accelerated decontrol could lower consumption outlays and hence, real GNP. Real disposable incomes--the principal determinant of consumer spending--would fall unless wage increases manage to keep pace with the rate of inflation. Inflation-induced tax "bracket creep" and reductions in the real values of financial assets would also result in relative declines in real disposable income.

The effects of higher prices on interest rates under natural gas decontrol may also reduce total real spending. Higher prices would generally lead to increases in the demand for money to finance higher levels of nominal spending. Depending on actions taken by the Federal Reserve Board, interest rates could rise if credit tightens. Total real spending may tend to fall as higher interest rates increase the costs of financing investment expenditures by businesses and mortgage and durable goods (e.g., automobiles) expenditures by households.

The estimates provided by the DRI and Wharton models (Table 6) of the real GNP impacts of decontrol generally reflect this reasoning. Changes in prices and interest rates are the major mechanisms underlying the simulation results. During 1982-1984, full decontrol may lower real GNP by about $28 to $40 billion compared to current policy. Approximately half of the reduction in total real GNP as estimated by the DRI model is due to lower levels of investment. In the Wharton simulation, the reduction in real GNP is explained largely by reduced real consumption expenditures. These patterns reflect the larger impact of the increase in gas prices on interest rates in the DRI analysis compared to the larger impact on real disposable incomes in the Wharton analysis. The differential impacts of full decontrol on consumption and investment in the DRI and Wharton models account for nearly all of the total cumulative difference of $6.8 billion between the two simulations.

16/ However, an increase in money growth intended to offset declines in economic activity could contribute to higher rates of inflation in the future.

With phased decontrol, the cumulative impact on real actual GNP would be reduced by as much as $16.9 billion, or from $39.9 to $23.0 billion, compared to full decontrol. This reduction in real GNP losses reflects the smaller increases in gas prices under phased decontrol. Hence, the inflation and interest rate effects would be smaller, mitigating the impacts on real consumption and investment expenditures. In addition, the gradual increase in gas prices would tend to delay the maximum impacts on real actual GNP, compared to full decontrol.

Table 6

Real GNP Impacts of Accelerated Decontrol
(1980 $ Billions)

	Current Policy		Full Decontrol:				Phased Decontrol:a/	
	DRI	Wharton	DRI	%	Wharton	%	DRI	%
1982	2767.6	2764.8	- 8.9	-0.3	-11.7	-0.4	- .9	-0.0
1983	2930.3	2872.3	-17.8	-0.6	-10.1	-0.4	- 6.6	-0.2
1984	3062/4	2996.6	-13.2	-0.4	- 5.9	-0.2	-15.5	-0.5
Total 1982-84			-39.9		-27.7		23.0	

---

a/ Effects of phased decontrol were simulated only with the DRI Model.

Impacts on Unemployment

The effects of higher gas and overall prices on total real output in the short-run will have similar impacts on the rate of unemployment. Levels of employment in the economy tend to reflect overall levels of economic activity. If the price effects of accelerated decontrol dampen aggregate demand and output, the demand for labor by firms will also fall, causing the unemployment rate to rise.

The DRI and Wharton simulations results are consistent with this explanation. For both full and phased decontrol, changes in the level of unemployment (Table 7) follow a pattern similar to changes in the level of real GNP. The unemployment rate tends to rise as total output and aggregate demand decline. Estimates provided by the two models of the unemployment rate impacts for full decontrol are virtually the same. Each one-tenth of one percentage point increases amounts to a loss of roughly 100,000 to 150,000 jobs.

Table 7

Unemployment Rate Impacts of Accelerated Decontrol

	Current Policy		Accelerated Decontrol[a]		Phased Decontrol[a]
	DRI	Wharton	DRI	Wharton	DRI[b]
1982	7.3	7.6	0.1	0.2	0.0
1983	6.6	7.3	0.2	0.1	0.1
1984	6.1	6.3	0.2	0.0	0.2

---

[a] Percentage Point change from current policy.

[b] Unemployment effects simulated only with the DRI Model.

5. Summary

Theories and econometric models of the demand-side mechanisms of the macroeconomy predict that accelerated natural gas price decontrol will have impacts on inflation, unemployment and output. The magnitudes of the estimated impacts are not large and they fade over time. Most of these impacts would originate from the higher prices paid by households for gas and for some goods and services that use gas.

Estimates derived using the DRI and Wharton macroeconomic models indicate that full supply/demand decontrol in 1982 may add from 1.4 to 2.5 percentage points to the rate of increase in inflation (GNP deflator) in that year. The inflation effects of phased decontrol tend to be smaller in magnitude and are spread over a longer period. The demand-side aggregate price effects of decontrol would be accompanied by a temporary reduction of real expenditures as measured by real GNP and an increase in the unemployment rate. Between 1982-1984, full decontrol may result in total cumulative losses in real GNP of between $28 to $40 billion , or roughly 0.5 to 0.6 percent per year. The cumulative losses for phased decontrol would be smaller ($23.0 billion, or .2 percent per year), corresponding to smaller impacts of prices under this option. Increases in the unemployment rate of .1 to .2 points would accompany real GNP losses of these magnitudes.

These estimates should not be interpreted as precise forecasts of economic conditions under accelerated decontrol. They require a careful interpretation, as the macroeconomic tools used were not designed specifically for analysis of alternative natural gas pricing policies. The major supply-side impacts of decontrol--changes in real resource costs and economic efficiency--were introduced into the DRI and Wharton model in imprecise and imperfect ways. Moreover, demand-side models tend to place their emphasis on short-term forecasting, yet many of the benefits of decontrol are anticipated to occur in the longer-term. Given these limitations, the analysis and results presented in this section should only be interpreted as rough approximations of the kinds of short-term, demand-side impacts accelerated decontrol may have on the economy. Of the impacts identified and estimated here, many forces could intervene to change their timing, magnitude, and even their direction.

III. CONCLUSIONS

Accelerated natural gas decontrol poses important implications for the potential and actual performance of the economy. Changes in natural gas policies would have direct effects on both those who use and those who produce natural gas. In some sectors, the effects of accelerated decontrol will be beneficial. Most obvious, decontrol would lead to substantial profits for gas producers. In other sectors, particularly residential users and others who cannot easily switch to other fuels, accelerated decontrol could have negative effects in the short-term because of the significant increases in gas costs anticipated to occur. Accompanying direct impacts such as these would also be a wide range of effects on the overall economy. These effects--the "general equilibrium" consequences of accelerated decontrol--are the focus of this analysis.

For this assessment, the impacts of accelerated decontrol have been differentiated according to whether they occur on the supply-side or demand-side of the economy. On the supply-side, decontrol may have significant consequences for availability, allocation, and productivity of our nation's economic resources. On the demand side, higher prices for natural gas and gas-intensive goods and services may raise the rate of inflation, reduce total expenditures, and increase the level of unemployment. These effects should only be temporary, however. Moderations in the rates of increases in gas prices would be followed by progressively smaller impacts on the overall economy.

Many of demand and supply-side effects of accelerated decontrol, although differentiated for this analysis, nevertheless may be closely connected and may occur at the same time. Any economic costs that do arise as a result of either demand or supply-side effects should occur only in the short-term. The underlying reason why both potential and the actual output of the economy may drop in the near-term is the same: households and firms alike would incur economic costs to making adjustments to the direct and indirect effects of changes in the price and availability of gas.

The short-term costs of decontrol, however, must be weighed against the long-term benefits. The principal benefit takes the form of higher real potential output in the long-term. As potential output rises, the prospects for increases in actual output are improved. Higher potential output would also permit lower levels of inflation and unemployment. For these important reasons, natural gas decontrol provides a key opportunity to improve overall economic performance in the long-term.

25

ATTACHMENT I

THE MACROECONOMIC EFFECTS OF NATURAL GAS PRICE DECONTROL

Prepared Under Subcontract by
Dale W. Jorgenson Associates
Cambridge, Massachusetts 02138

Under Contract No: AC01-79PE-70046

TABLE OF CONTENTS

EXECUTIVE SUMMARY

1. INTRODUCTION

2. ASSUMPTIONS AND METHODOLOGY

3. THE MACROECONOMIC EFFECTS OF FULL DECONTROL

4. THE DETAILS OF ADJUSTMENT TO FULL DECONTROL
    - 4.1 Changes in Factor Inputs
        - 4.1.1 Labor Supply
        - 4.1.2 Capital Availability
    - 4.2 Changes in Productivity Conditions
        - 4.2.1 Release of Resources from Gas Supply
        - 4.2.2 Changes in Imports and Exports
        - 4.2.3 Changes in Input Patterns
        - 4.2.4 Changes in the Mix of Economic Outputs
    - 4.3 Summary of Effects

5. MACROECONOMIC EFFECTS OF PHASED DECONTROL

ANNEX

EXECUTIVE SUMMARY

This analysis examines the impacts on future production and real incomes of accelerated natural gas price decontrol. Specifically, it compares overall economic performance under current energy policy conditions, which include partial decontrol in 1985, to that arising from full price deregulation in 1982 and from phased deregulation by 1985. The information base for this assessment is provided by the Division of Energy Deregulation, Office of Policy, Planning, and Analysis, DOE. The source of this information is a detailed analysis of the effects of these policy changes on gas prices, gas and petroleum supply and demand patterns, production requirements for gaseous fuels, corporate and shareholder earnings, and government revenues. This detailed information is introduced directly into the Dynamic General Equilibrium Model (DGEM) of energy and the economy. The remaining adjustments are determined within DGEM, thus providing estimates of the influence of decontrol on the growth and structure of the U.S. economy. The energy-economy modeling framework within DGEM accommodates all of the adjustment mechanisms contained in the detailed gas market assessment and, accordingly, the simulation offers a comprehensive economic evaluation of the changes arising from decontrol. A summary of the estimated macroeconomic impacts appears in the accompanying table.

Over the long-run, accelerated decontrol of natural gas prices results in a net economic benefit. This benefit takes the forms of higher output and real incomes. Over the period 1982 to 1995, the sum of the gains in real GNP for full decontrol is estimated to be $(1972) 23.0 billion (bn). This is only 1.6 percent of the level of real GNP achieved in 1980. Using a 6.0 percent discount rate, the present value to 1981 of the real GNP changes over the 1982 to 1995 period is calculated to be $(1972) 10.0 bn ($17.9 bn in constant dollars of 1980).

From this, it can be noted that the macroeconomic consequences of accelerated decontrol are relatively small. The economy maintains positive growth throughout the projection period as it adjusts to and absorbs the effects of decontrol.

Ultimately, both capital and labor share in the annual benefit of increased production, although the owners of capital experience the greater gains in real income. However, over the entire period 1982 to 1995, only the owners of gas-related capital secure a real income benefit. Under full decontrol, real income to labor is projected to fall by a total of $(1972) 29.9 bn and the cumulative loss in other capital income is

SUMMARY OF THE MACROECONOMIC EFFECTS OF FULL DECONTROL IN 1982 OF NATURAL GAS PRICES
(Billions of 1972 Dollars)

Changes from the current policy situation in:

	Real GNP	Gross Income		
		Labor	Capital	
			Gas-Related	Other
1982	-4.8	-20.9	18.8	- 2.7
1983	-3.8	-18.6	17.2	- 2.4
1984	-3.1	-16.9	16.5	- 2.7
1985	2.2	0.5	2.3	- 0.6
1986	2.9	1.3	2.4	- 0.8
1987	3.2	2.1	1.9	- 0.8
1988	2.9	2.1	1.5	- 0.7
1989	3.2	2.5	1.5	- 0.8
1990	3.4	2.8	1.3	- 0.7
1991	3.0	2.6	1.1	- 0.7
1992	3.4	2.9	1.2	- 0.7
1993	3.7	3.9	0.5	- 0.7
1994	3.4	2.9	1.3	- 0.8
1995	3.4	2.9	1.2	- 0.7
Cumulative Effect	23.0	-29.9	68.7	-15.8
Net Present Value in 1981 at 6.0%	10.0	-35.4	57.2	-11.8

estimated to be $(1972) 15.8 bn. These reductions are more than compensated by an overall increase in gas-related capital income of $(1972) 68.7 bn. If the time pattern of these changes is adjusted by discounting (again, at a 6.0 percent discount rate), then the change in labor income has a present value of - $(1972) 35.4 bn while total capital income rises by $(1972) 45.4 bn. Within this rise in total capital income, the present value of the income gains to the owners of gas-related capital is $(1972) 57.2 bn, whereas other capital income is diminished by a total of $(1972) 11.8 bn. Thus, accelerated decontrol involves a relative shift of real income or purchasing power from the owners of labor services to the owners of capital services and, among the latter, from the owners of other capital assets to those having claims on the capital associated with domestic gas supply.

There is a clear and distinctive time pattern to the effects of accelerated decontrol--short run costs followed by benefits in the medium and long runs. Output losses average $(1972) 3.9 billion for the three years immediately following decontrol. Reductions in labor income are even more significant, averaging $(1972) 18.8 billion for the same period, and are compensated only partially by increases in capital income. However, from 1985 onward, accelerated decontrol is beneficial. Output and income are somewhat higher than under current policy conditions and both capital and labor are recipients of this benefit. It is important to note however, that the projection horizon must be extended to 1990 before the early losses are offset by subsequent gains. It takes about nine years for the overall effects to become positive (in present value terms). The present value of the change in capital income is positive from the outset, but even by 1995 the change in real labor income has a negative present value.

The macroeconomic effects of phased decontrol are similar in timing and direction, though slightly smaller in magnitude. As with full decontrol, phased decontrol causes economic losses over the 1982-84 period and economic benefits thereafter, compared to present policy. From 1982 to 1995, the cumulative gain in real GNP for phased decontrol is estimated to be $(1972) 21.4 billion, or $(1972) 1.6 billion less compared to full decontrol. However, using a six percent discount rate, the cumulative gains are virtually identical between the two alternative policies, or roughly $(1972) 10 billion in each case. The comparison between immediate and phased decontrol involves the tradeoff between larger initial losses with greater long-term benefits (immediate decontrol) and smaller initial losses and smaller long-term benefits (phased decontrol). The tradeoff, in turn, reflects smaller gas price increases but also smaller real resource benefits under phased decontrol. Whether, on a net present value basis, the cumulative macroeconomic benefit is higher under one policy compared to the other depends critically on the discount rate.

These estimates of the macroeconomic effects of accelerated natural gas price decontrol, and consideration of the causal mechanisms involved, suggest that decontrol has some, but relatively small, effects on total production. The initial impacts on real GNP are negative but, as the time horizon is extended, the total net impacts become positive. From a public policy perspective, these findings imply that assessment of the macroeconomic case for accelerated decontrol depends critically on the planning or decision horizon: if short term considerations are of principal importance, then the macroeconomic impact is negative; but, from the point of view of the longer run health and performance of the economy, accelerated decontrol is advantageous.

1. INTRODUCTION

This analysis examines the consequences of accelerated natural gas price decontrol for overall economic performance. In particular, emphasis is placed on the influence of this policy change on the growth and structure of real incomes and production. Numerical estimates of these are developed for the period 1982-1995 under a policy position that assumes full decontrol of natural gas prices in 1982. These are compared to the patterns occurring with current policy in which partial decontrol begins in 1985. The analysis is based on simulations using the Dynamic General Equilibrium Model (DGEM), originally developed by Hudson and Jorgenson and subsequently updated and extended by Goettle and Hudson. In response to the change in energy policy, DGEM generates a detailed assessment of economic growth and the structural aspects of energy-economy interactions.

The energy assumptions for this analysis were provided by the Division of Energy Deregulation within the Office of Policy, Planning, and Analysis, U.S. Department of Energy. Much of the information was developed from simulations of the Two Market Model[1/] under the specified policy conditions. The changes promoted by early decontrol and measured in the DOE analysis were introduced into DGEM to ascertain the nature and magnitudes of the economic adjustments. The results from these assessments form a comprehensive information base for use in evaluating the effects of the decontrol decision.

1/ The Two Market Model and its simulation results are described in a separate appendix to the study (Appendix A).

2. ASSUMPTIONS AND METHODOLOGY

The Division of Energy Deregulation provided information for two projections from the Two Market Model covering the period 1980-1995. These projections correspond to a Reference case, in which the effects of current policy (i.e., partial decontrol in 1985) are represented, and a Decontrol case, in which full decontrol of natural gas prices occurs in 1982. This information is organized into the following categories:

- Domestic gas supply and the average domestic supply price;
- Imported gas supply and the average import price;
- Gas consumption patterns and delivered gas prices in the residential, commercial, industrial, and electric utility sectors for the combined inter- and intrastate markets;
- Petroleum consumption patterns and the average delivered petroleum price for the industrial and electric utility sectors combined;
- The pattern of real resources for natural gas supply in each projection;
- The disposition of new gas market revenues to governments, shareholders, and corporate savings.

The existing DGEM Reference case was selected as the starting point for the analysis. A comparison of the DGEM and DOE Reference cases reveals only slight differences in gas supply and demand patterns. Further, the energy policy and world oil price assumptions underlying the two cases are very similar. Oil price decontrol is accomplished in 1981 and gas price decontrol begins in 1985. The impacts of other energy policies, e.g., the Powerplant and Industrial Fuel Use Act (PIFUA), are also included where appropriate.

In simulating the response of the economy to accelerated natural gas price decontrol, virtually all of the information provided by the Division of Energy Deregulation was incorporated into DGEM. DGEM was constrained to align with all the price and certain of the quantity responses on both the supply and demand sides of the gas market. This included adjustments in gas consumption rates for the manufacturing and electric utility sectors and delivered gas prices to the household, manufacturing, services, and electric utility sectors. It also included changes in the price of gas imports. Total use of petroleum in the industrial and electric utility sectors combined was constrained to match the projected consumption patterns. Real resource effects in the natural gas supply sector were introduced through changes in the production function for this output. Finally, the disposition of net gas market revenues was incorporated by modeling the financial flows to governments, shareholders, and corporations.

The information from the Division of Energy Deregulation was introduced into DGEM as follows. From the DOE projections, percentage changes in the gas import price and in the delivered gas prices to each consuming sector were computed and then applied to the corresponding variables in DGEM. Similarly, gas demand in the industrial and utility sectors was constrained in DGEM to match the relative responsiveness to decontrol that was observed in the DOE analysis. However, the demand response in the residential and commercial sectors was determined within the DGEM simulation framework. Thus, changes in domestic gas supply, total production costs (real resources), gas market revenues, and producer surplus also were estimated by DGEM. The gas supply and demand information that was introduced into DGEM is shown in Tables 1 and 2.

There is also an effect from decontrol on the domestic petroleum market that must be incorporated. This involves the impact of decontrol on the quantity of petroleum consumed in the industrial and electric utility sectors. Accordingly, the change in total petroleum consumption in these sectors is constrained to that determined in the DOE analysis. Table 3 shows the petroleum quantity adjustment.

As indicated above, certain changes in the gas market were not aligned to those projected in the DOE analysis. Rather, they were determined within the general equilibrium framework.

Table 4 shows the simulated demand response to the projected changes in gas prices confronting residential and commercial customers. Within these sectors and for the same proportionate increases in price, the demand adjustments estimated by DGEM are larger, in absolute terms, than those observed from the gas market model. This condition holds in both the near- and long-term quantity projections and the differential response increases over time. This pattern simply indicates the presence, within DGEM, of larger gas demand elasticities and, over time, more rapid and complete adjustments to gas price changes.

Table 1

PERCENTAGE CHANGES IN GAS DEMAND QUANTITIES AND PRICES APPLIED TO DGEM VARIABLES

Year	Residential (Household)	Commercial (Services)	Industrial (Manufacturing)		Electric Utility	
	% P	% P	% Q	% P	% Q	% P
1982	42.23	45.98	7.97	59.37	11.23	69.71
1983	35.81	39.15	9.62	53.45	13.90	64.33
1984	32.30	35.49	9.31	50.57	21.84	64.84
1985	0.46	0.16	2.98	-2.32	-1.03	-3.26
1986	1.04	0.78	-0.64	-1.06	-1.98	-1.96
1987	2.68	2.33	-2.37	-0.35	-5.71	-1.57
1988	1.88	1.66	-1.29	-0.84	-5.77	-1.69
1989	2.10	1.90	-2.26	-0.65	-6.88	-1.14
1990	2.04	1.70	-2.75	-0.63	-7.39	-0.79
1991	1.58	1.37	-1.79	-0.91	-6.35	-0.76
1992	1.79	1.60	-2.96	-0.59	-7.41	-0.44
1993	1.49	1.16	-1.61	-0.86	-6.00	-0.43
1994	1.82	1.64	-3.52	-0.42	-7.73	0.28
1995	1.89	1.71	-3.38	-0.27	-7.78	0.40

Table 2

PERCENTAGE CHANGES IN GAS IMPORT QUANTITIES AND PRICES

Year	Imported Supply, %	Gas Import Price, %
1982	0	- 6.04
1983	0	- 6.96
1984	0	- 6.33
1985	0	-31.07
1986	0	-25.97
1987	0	-16.64
1988	0	-14.93
1989	0	-13.01
1990	0	-11.59
1991	0	-10.69
1992	0	- 9.23
1993	0	- 8.68
1994	0	- 7.31
1995	0	- 6.83

Table 3

CHANGE IN PETROLEUM CONSUMPTION IN THE INDUSTRIAL AND ELECTRIC UTILITY SECTORS

(Quadrillion Btu)

Year	Reference Case	Decontrol Case	Change
1982	3.4	2.6	-0.8
1983	3.4	2.4	-1.0
1984	3.6	2.5	-1.1
1985	2.9	2.7	-0.2
1986	2.8	2.9	0.1
1987	2.7	3.0	0.3
1988	2.9	3.2	0.3
1989	3.3	3.6	0.3
1990	3.6	4.0	0.4
1991	3.8	4.1	0.3
1992	4.0	4.4	0.4
1993	4.2	4.5	0.3
1994	4.4	4.8	0.4
1995	4.5	4.9	0.4

Table 4

RESIDENTIAL AND COMMERCIAL GAS CONSUMPTION UNDER FULL DECONTROL

(Trillion Cubic Feet per Year)

Year	Residential Demand	Commercial Demand
1982	4.378	2.543
1983	4.339	2.492
1984	4.311	2.417
1985	4.913	2.765
1986	4.904	2.758
1987	4.879	2.742
1988	4.890	2.746
1989	4.871	2.735
1990	4.865	2.734
1991	4.901	2.738
1992	4.918	2.733
1993	4.950	2.740
1994	4.966	2.732
1995	4.989	2.730

Combining gas consumption in the residential and commercial sectors with demand in industry and electric utilities provides an estimate of total final domestic demand. Domestic supply, or production, is determined as domestic demand plus natural gas consumption in pipelines and by gas producers less gas imports. Estimates of the fractional amounts of total gas supply, i.e., domestic and imported, that are consumed in gas transportation and production were obtained directly from the DOE information and incorporated into the DGEM simulation. Thus, with given gas import quantities, the determination of total demand permits the immediate estimation of domestic supply. The projected levels of domestic demand and supply appear in Table 5. In comparison to the DOE analysis, the change in total gas demand is larger, in absolute terms, since the responses in the residential and commercial sectors are larger. This has a direct effect on domestic supply under accelerated decontrol; as the demand impacts within DGEM are comparatively larger so, too, are the supply effects. On an annual basis, supply reductions in DGEM are larger than those estimated by DOE and the same is true for supply increases.

In the DOE analysis, real resource costs are defined to be the total cost of domestic gas production from all sources, i.e., the area under the domestic gas supply curve, plus gas import payments. In DGEM, these component effects must be isolated and introduced separately so as to reflect accurately the real resource implications of accelerated decontrol. The change in gas import payments is represented explicitly in DGEM. (The change is computed by applying the percentage changes in Table 2 to the corresponding values of DGEM variables.) Thus, the value of gas imports must be eliminated from DOE's real resource costs. The remaining cost component represents the real resources, i.e., economic inputs, associated with domestic gas production. Within DGEM, the unit cost of domestic supply is adjusted so that the percentage change in real resources devoted to domestic production matches that given by the product of DOE's estimated unit cost and the endogenously determined domestic supply. The resulting real resource effect is presented in Table 6.

The differential supply response between the two analyses affects the magnitude of change in producer surplus. In the Reference case, producer surplus is computed as the difference between gas market revenues (total domestic supply times the average wellhead price) and real resources allocated to domestic gas production (Table 6). Under accelerated decontrol, producer surplus is determined in an identical manner. Gas market revenues are the product of the domestic supply estimates from Table 5 and the deregulated average wellhead price from the DOE

Table 5

DOMESTIC GAS DEMAND AND SUPPLY UNDER FULL DECONTROL

(Trillion Cubic Feet per Year)

Year	Domestic Demand	Domestic Supply
1982	17.038	18.189
1983	16.860	17.437
1984	16.453	16.917
1985	16.952	17.317
1986	16.998	17.263
1987	17.132	17.360
1988	17.233	17.477
1989	17.049	17.267
1990	16.879	17.072
1991	16.861	17.051
1992	16.696	16.864
1993	16.704	16.573
1994	16.510	16.651
1995	16.447	16.583

Table 6

CHANGE IN REAL RESOURCE COSTS ASSOCIATED WITH DOMESTIC GAS PRODUCTION

(Billions of 1980 Dollars)

Year	Reference Case	Decontrol Case	Percentage Change
1982	38.5	37.9	-1.56
1983	38.3	38.1	-0.52
1984	38.9	38.7	-0.51
1985	43.2	42.9	-0.69
1986	47.2	45.5	-3.60
1987	52.4	49.7	-5.15
1988	54.1	52.0	-3.88
1989	55.5	52.7	-5.05
1990	56.4	53.4	-5.32
1991	57.2	54.9	-4.02
1992	58.6	55.4	-5.46
1993	59.1	55.9	-5.41
1994	60.7	57.2	-5.77
1995	61.9	58.4	-5.65

analysis. Producer surplus is the difference between the average from domestic supply and the resources required for production (the decontrol column of Table 6). The change in producer surplus is, then, the difference between these two amounts and the change in corporate income taxes is approximately 17.5 percent (the effective tax rate on capital income) of this difference. The simulated changes in these gas-market variables are shown in Table 7.

In DGEM, there is the requirement that the revenues received by a sector are balanced exactly by payments to inputs, including income to capital, and payments to governments. Typically, this disposition of revenues is endogenous to the simulation. However, there are several input assumptions that provide important information on government revenues, stockholder dividends, and retained earnings. Thus, it is appropriate to introduce specific changes in the financial flows accruing to governments, shareholders, and corporate saving. Government revenues in the DOE analysis originate from two sources: severance taxes and royalties on gas production; and state and federal taxes on corporate income. Changes in severance taxes and royalties (Table 8) are computed as functions of the changes in producer surplus and gas market revenues, respectively. These are incorporated into the simulation in current dollars, i.e., the real magnitudes are adjusted by the GNP price deflator. As indicated, changes in corporate income taxes are determined by applying the effective tax rate on capital income to the difference between real gas market revenues and real resource requirements and, then, adjusting to current dollars. The nontax component of this surplus accrues to gas producers. The annual increment in government revenues is directed toward a reduction in the on-budget deficit that otherwise would occur. The increased flow of after-tax profits that results from decontrol is represented as a transfer of capital income that is either distributed to shareholders in the form of increased dividends or retained by the corporations involved in natural gas production. In the DOE analysis, the ratio of retained earnings to dividends averages 2.27 to 1.0 and this allocation of the nontax portion of producer surplus was also used in DGEM. Although retained earnings and dividends have different impacts on the spending-saving and the labor-leisure choices, each contributes dollar-for-dollar to the change in the capital component of national income.

The final assumption concerns the international trade aspects of the decontrol situation. Changes in the value of energy imports (both petroleum and natural gas) will lead to a series of adjustments involving capital flows, exchange rates, and export volumes. U.S. experience during the 1970's indicates the

Table 7

CHANGE IN PRODUCER SURPLUS AND CORPORATE INCOME TAXES

(Billions of 1980 Dollars)

Year	Change in Producer Surplus	Change in Corporate Income Taxes
1982	35.6	6.22
1983	32.7	5.71
1984	31.3	5.46
1985	4.5	0.79
1986	4.6	0.80
1987	3.7	0.65
1988	2.9	0.51
1989	2.8	0.49
1990	2.5	0.44
1991	2.1	0.37
1992	2.2	0.38
1993	1.0	0.17
1994	2.5	0.44
1995	2.3	0.40

Table 8

CHANGE IN SEVERANCE TAXES AND ROYALTIES
(Billions of 1980 Dollars)

Year	Reference Case	Decontrol Case	Change
1982	3.0	7.7	4.7
1983	3.1	7.4	4.3
1984	3.3	7.5	4.2
1985	7.3	7.9	0.6
1986	7.6	8.1	0.5
1987	8.0	8.4	0.4
1988	8.4	8.7	0.3
1989	8.8	9.0	0.2
1990	9.1	9.3	0.2
1991	9.5	9.6	0.1
1992	9.8	9.9	0.1
1993	10.2	10.1	-0.1
1994	10.5	10.6	0.1
1995	10.9	11.0	0.1

following set of adjustments to increased oil import-payments--a rise in the total import bill, accommodated in the short run by international capital movements, rapidly leads to exchange rate changes which, in turn, induce increased export volumes and reduced volumes of nonenergy imports. This same response is assumed to occur in the case of natural gas price decontrol. The key points are that any changes in import payments are accompanied by exchange rate adjustments and by adjustments in export volumes. These adjustments are assumed to continue until the nominal, or current dollar, balance of trade is restored to the same level as in the Reference or present policy case. This adjustment mechanism does have important implications for the general economic effects of decontrol--to the extent that decontrol causes a reduction in energy import expenditure and a less-than-compensating increase in nonenergy imports, production for exports can be reduced and the resources and output available to sustain domestic consumption and investment expenditures are correspondingly increased.

3. THE MACROECONOMIC EFFECTS OF FULL DECONTROL

Under the conditions of this analysis, full decontrol of natural gas prices in 1982 is seen to have some, though not substantial, effect on overall economic performance. A summary of the major results appears in Tables 9 and 10. In the long run, accelerated decontrol yields a small, net economic benefit. This benefit appears as higher cumulative output and incomes and a virtually neutral inflationary effect over the period 1982 to 1995. Within this overall impact, there is a distinct time pattern of adjustment. Initially the consequences of decontrol are adverse. However, these rapidly give way to compensating impacts which, through time, balance the earlier costs and, ultimately, secure an overall benefit. None of the consequences of accelerated decontrol is large; the costs are relatively small and shortlived, while the benefits are even smaller but sustained.

The cumulative gain in real GNP is estimated to be $(1972) 23.0 billion by 1995. Real output and incomes are reduced, in comparison to the current policy situation, through 1985. Economic losses are limited to the three years immediately following full decontrol. Recovery from the initial effects of decontrol occurs from 1985 onward with increases in the annual rate of output and income. This process is initiated by a continuing increase in capital availability which begins in 1983 and results from a shift in spending patterns away from household consumption of goods and services and toward saving and investment.

The price effects of this policy change follow an identical time pattern; prices are higher through 1984 and are lower in each subsequent year. Deregulation in 1982 imposes a small inflationary cost, but the penalty that would otherwise occur in 1985 is avoided. This inflationary effect is viewed from the perspective of supply (or cost); desired expenditure (demand) is always consistent with what is achievable from production, i.e., the supply and capacity potentials of the economy. The overall price effects from accelerated decontrol result from the influence of changes in the gas market on relative production costs, factor availabilities and productivities, input and spending patterns and, so, output prices. The impact on the price level and rate of inflation is expressed in relative terms; price outcomes are governed by the changes in supply and demand equilibriums within each factor and product market and are measured against the wage rate (labor price) received by households which serves as the numeraire. The changes in economic conditions that follow from accelerated decontrol are money-neutral, i.e.,

Table 9

OVERVIEW OF ECONOMIC IMPACTS OF FULL DECONTROL

	Real GNP Under Current Policy	Estimated Real GNP Effect of Decontrol		Estimated Inflation Effect of Decontrol
Year	$(1972) Billions	$(1972) Billions	%	Percentage Point
1982	1560.3	-4.8	-0.31	2.18
1983	1605.6	-3.8	-0.24	-0.33
1984	1657.5	-3.1	-0.19	-0.24
1985	1689.9	2.2	0.13	-1.72
1986	1735.1	2.9	0.17	-0.06
1987	1787.2	3.2	0.18	-0.06
1988	1849.3	2.9	0.16	0.00
1989	1890.8	3.2	0.17	-0.02
1990	1940.2	3.4	0.18	-0.01
1991	1991.8	3.0	0.15	0.03
1992	2050.8	3.4	0.17	-0.02
1993	2100.8	3.7	0.18	-0.06
1994	2160.7	3.4	0.18	0.08
1995	2224.5	3.4	0.15	0.00

Table 10

CUMULATIVE EFFECTS OF FULL DECONTROL

	Cumulative Real GNP Effect $(1972) Billions Discount Rate:		
Year	0 Percent*	6 Percent*	Percentage Change In Price Level
1982	- 4.8	- 4.5	2.00
1983	- 8.6	- 7.9	1.69
1984	-11.7	-10.5	1.46
1985	- 9.5	- 8.7	-0.15
1986	- 6.6	- 6.6	-0.20
1987	- 3.4	- 4.3	0.26
1988	- 0.5	- 2.4	-0.25
1989	2.7	- 0.4	-0.27
1990	6.1	1.6	-0.29
1991	9.1	3.3	-0.26
1992	12.5	5.1	-0.27
1993	16.2	7.0	-0.33
1994	19.6	8.6	-0.25
1995	23.0	10.0	-0.25

---

* Cumulative net present value in 1981.

monetary aggregates accommodate the equilibrated changes in aggregate supply and demand. Further, no price-wage-price spiral mechansim is included. This limits the process of adjustment and, hence, the overall price impact to that which is solely attributable to the change in gas policy.

The causal mechanisms that link accelerated decontrol to overall economic performance are complex and they change over time. Decontrol leads to adjustments in production costs and output prices, sectoral demands and supplies and their aggregations, factor availabilities, financial flows, and productivity conditions. Given the general equilibrium nature of DGEM, it is impossible to isolate completely the magnitude of the GNP impact associated with each of these changes. However, it is possible to quantify components of the overall response and, from these, identify both the nature and time pattern of the individual adjustment mechanisms.

For ease of exposition, the real GNP impact is decomposed into two effects: that from a change in factor inputs, i.e., capital and labor, and a residual which summarizes the combined impacts of a series of adjustments on total factor productivity. Table 11 provides this decomposition. This information reveals the change in productivity to be the dominant cause of the early economic costs of decontrol. In 1982, there is a very small increase in labor supply and no change in capital availability, since it is fixed by the beginning-of-year capital stock. Thus, the change in factor inputs contributes a small economic gain within the overall loss. From 1983 onward, there occur small reductions in labor supply, but the availability of capital is increased because real investment is higher in all periods (1982-1995) under this policy change. Further, the rise in capital input is of sufficient magnitude so that its impact on real GNP dominates that from the labor reduction. Therefore, in all years the effect on output and income of changes in factor inputs is positive. All other things being equal, real GNP under accelerated decontrol should be higher than with current policy. But, all other things are not equal. In the three years immediately following decontrol, impacts leading to large, adverse changes in productivity more than offset the effects of changes in input supplies. From 1985 onward, the productivity consequences are varied. There are small productivity costs occurring through 1988, almost neutral impacts over the period 1989-1991, and small productivity improvements thereafter.

In summary, labor input reductions have an adverse impact on real output throughout most of the projection horizon. Changes in productivity conditions also result in economic costs over

Table 11

PRINCIPAL COMPONENTS OF REAL GNP EFFECT

(Change, Percentage Points)

Year	Real GNP Effect	Component Due to: Change in Factor Inputs*	Component Due to: Residual, Change in Productivity
1982	-0.31	0.01	-0.32
1983	-0.24	0.10	-0.34
1984	-0.19	0.18	-0.37
1985	0.13	0.21	-0.08
1986	0.17	0.21	-0.04
1987	0.18	0.21	-0.03
1988	0.16	0.18	-0.02
1989	0.17	0.18	-0.01
1990	0.18	0.18	0.00
1991	0.15	0.16	-0.01
1992	0.17	0.15	0.02
1993	0.18	0.13	0.05
1994	0.16	0.12	0.04
1995	0.15	0.11	0.04

---

* Determined as the weighted sum of the percentage changes in capital and labor inputs. Weights are provided by the value shares in gross national income; labor 0.64 and capital 0.36.

much of the 1980's, providing sustained benefits only in the 1990's. However, these changes are small in comparison to the capital changes. From 1983 onward, capital availability is higher under accelerated decontrol. This partially compensates the adverse GNP impacts in 1983 and 1984 and permits the sustained increase in the output achievable from production in all subsequent years.

4. THE DETAILS OF ADJUSTMENT TO FULL DECONTROL

4.1 Changes in Factor Inputs

4.1.1 Labor Supply

Full decontrol involves a very small increase in labor supply in 1982 and small reductions in supply in each year thereafter. These changes are shown in Table 12. The factors affecting labor supply are changes in wealth, dividends and retained earnings, and consumption prices relative to the wage rate. Increases in wealth and gas-related capital income encourage leisure, whereas an increase in consumption prices stimulates labor supply. The numerical relationships that characterize the labor response in this analysis can be indicated:

- each $ 1 billion increase in wealth leads to a 0.022 percent reduction in labor supply;
- each $ 1 billion increase in dividends results in a 0.0051 percent reduction in labor supply;
- each $ 1 billion increase in the earnings retained by natural gas producers reduces labor supply by 0.0025 percent;
- each 1 percent increase in consumption prices, relative to wages, leads to a 0.27 percent increase in labor supply.

Dividends and retained earnings are increased in all years as a result of deregulation, with particularly large increases over the 1982-84 period (i.e., the period before decontrol under present policy conditions). These changes exert downward pressure on labor supply.

The nominal value of private wealth also increases in all years, adding further downward pressure on labor supply. Nominal wealth is measured as the real quantity or stock of all private human and nonhuman capital valued at current (or replacement) prices. Human capital is unaffected by accelerated decontrol; the total time endowment for labor-leisure decisions remains constant across cases, as does the numeraire price of labor and lesiure. Thus, changes in wealth are solely attributable to changes that operate on the nonhuman component. These changes arise from both price and quantity considerations. Full decontrol in 1982 involves large and immediate increases in the

Table 12

IMPACT OF DECONTROL ON LABOR SUPPLY

(Percentage Change from Current Policy Case)

Year	Labor Supply Effect
1982	0.01
1983	-0.03
1984	-0.05
1985	-0.11
1986	-0.10
1987	-0.08
1988	-0.09
1989	-0.08
1990	-0.07
1991	-0.07
1992	-0.07
1993	-0.06
1994	-0.06
1995	-0.06

prices of natural gas to producers and consumers. For producers, these price increases represent a significant increase in production costs which, in working their way through the interindustry system, lead to higher output prices. In 1982, this causes a revaluation of the beginning-of-year stock of wealth due to one-time increase in capital gains. Labor supply is reduced accordingly. In 1983 and 1984, these price effects continue leading to further increases in nominal wealth and additional reductions in labor supply. But there also occurs an increase in capital stock that results from higher savings and investment. Since the price changes now are applied to a larger base, the influence of wealth on labor supply is that much stronger, although the capital gains effects are no longer present.

The year 1985 is a transition year for the price effects from decontrol. Under present policy, this is the year in which natural gas prices are deregulated partially. Under decontrol, gas prices are actually slightly lower and are only moderately higher from 1985 onward. Thus, output prices are only marginally affected by changes in the gas market. However, the increase in capital availability has secured a reduction in the price of capital relative to that of labor. The consequences of this relative price reduction dominate those of natural gas price changes; production costs and output prices fall relative to the current policy situation. As a result, the increases in wealth gradually diminish; the continuing higher base that results from higher savings and investment is revalued at lower prices. Smaller increases in wealth correspondingly lessen, but do not eliminate, the incentive for increased leisure demand at the expense of labor supply.

The price effects from decontrol also directly influence labor supply through their impacts on consumer prices. Over the period 1982-1984, consumer prices are higher. This stimulates labor supply, with the result that the labor reductions due to increases in wealth and gas-related capital income are more than offset in 1982 and partially compensated in the two succeeding years. From 1985 onward, consumer prices are lower under decontrol as a consequence of significantly reduced relative increases in gas prices and the decline in the relative price of capital. Lower consumer prices stimulate leisure demand. In this period, then, the influences of changes in wealth, dividends and retained earnings, and consumption prices on labor supply complement one another. This is the reason for the comparatively larger reductions in labor supply after 1984.

4.1.2 Capital Availability

Accelerated decontrol promotes an expansion in the productive capacity of the economy as real investment in all years is higher than in the Reference or present policy case. The mechanisms and variables underlying this change are shown in Tables 13 and 14. The capital input is unaffected in 1982, since it is limited by the beginning-of-year capital stock. However, from 1983 onward, capital availability under full decontrol exceeds that projected under current policy. All other things being equal, the change in capital supply increases the output and real income that the economy can achieve. Indeed, this rise in capital availability is the principal mechanism that reduces the earlier economic costs and secures the continuing economic benefit of accelerated natural gas price decontrol.

In the 1982 to 1984 period, private savings and investment increase substantially. There is a substantial rise in gas-related capital income, i.e., income to gas suppliers. This is reflected in higher dividends from and retained earnings in these industries. The upward movement in prices also leads to some increase in other capital income and nominal rates of return. From each of these sources there is a rise in private income. Decontrol leads to higher energy prices, to higher costs and to higher output prices, raising the average price of consumption goods and services. Households increase their consumption outlays but not by enough to offset the higher prices (there is a small reduction in real consumption). On balance, there is a smaller rise in consumption outlays than in income; the result is a rise in private savings. (Also, it can be noted that the additional income represented by higher retained earnings goes primarily into savings, very little is spent on consumption.)

Government revenues increase both due to higher income and other tax revenue from gas suppliers and due to the higher tax bases resulting from the higher general price level. As a consequence, the government deficit is reduced. Since government now absorbs a significantly smaller portion of private savings, higher private savings permit a substantial rise in investment outlays. Even allowing for higher prices of investment goods, real private investment is increased and capital availability is expanded.

From 1985 onward, income from all sources is slightly lower under accelerated decontrol. Reductions in labor and other capital income are greater, in absolute terms, than the

Table 13

IMPACTS OF FULL DECONTROL ON INCOMES, CONSUMPTION OUTLAYS, AND PRIVATE SAVINGS

(Change in Billions of Current Dollars)

Year	Labor Income	Capital Income*	Total Income*	Dividends, Retained Earnings	Consumption Outlays	Private Savings
1982	0.2	13.3	13.5	35.9	14.3	35.1
1983	-0.6	12.2	11.6	35.6	13.3	33.9
1984	-1.2	10.6	9.4	36.8	12.8	33.4
1985	-3.0	- 3.2	-6.2	5.6	-2.3	1.7
1986	-3.0	- 4.9	-7.9	6.2	-3.1	1.4
1987	-2.9	- 6.3	-9.2	5.4	-3.9	0.1
1988	-3.2	- 6.5	-9.7	4.5	-4.2	-1.0
1989	-3.2	- 7.6	-10.8	4.7	-4.8	-1.3
1990	-3.3	8.6	-11.9	4.5	-5.4	-2.0
1991	-3.6	- 8.4	-12.0	4.1	-5.4	-2.5
1992	-3.6	- 9.7	-13.3	4.6	-6.2	-2.5
1993	-3.6	-11.9	-15.5	2.2	-7.9	-5.4
1994	-3.9	-10.8	-14.7	5.8	-7.0	-1.9
1995	-4.1	-11.6	-15.7	5.6	-7.7	-2.4

---

* Exclusive of changes in nontax component of producer surplus, i.e., changes in dividends and retained earnings.

Table 14

IMPACT OF FULL DECONTROL ON SAVINGS, THE GOVERMENT DEFICIT, INVESTMENT, AND CAPITAL INPUT

(Change from Current Policy Case)

Year	Private Savings ($ Billion)1/	Government Deficit ($ Billion)1/	Investment Outlays ($ Billion)1/	Real Investment ($ 1972 Billions)	Real Investment (%)	Capital Input (%)
1982	35.1	-13.2	48.3	9.2	3.81	0
1983	33.9	-13.8	47.7	8.4	3.28	0.32
1984	33.4	-15.1	48.5	8.3	3.35	0.57
1985	1.7	-2.5	4.2	1.1	0.41	0.79
1986	1.4	-2.4	3.8	1.1	0.40	0.76
1987	0.1	-1.8	1.9	0.9	0.31	0.72
1988	-0.1	-1.4	0.4	0.6	0.21	0.68
1989	-1.3	-1.2	-0.1	0.6	0.20	0.64
1990	-2.0	-0.9	-1.1	0.5	0.16	0.60
1991	-2.5	-0.7	-1.8	0.4	0.11	0.56
1992	-2.5	-0.2	-2.3	0.4	0.12	0.52
1993	-5.4	1.0	-6.4	0.1	0.03	0.48
1994	-1.9	0.7	-2.6	0.4	0.11	0.44
1995	-2.4	1.8	-4.2	0.3	0.07	0.41

1/ In current dollars.

increases in gas-related capital income. But, consumption prices are somewhat lower and, although this leads to a higher volume of consumption, total outlays by households are reduced. As a result, private savings remain slightly higher through 1987 and slightly lower thereafter. Reductions in the overall government deficit continue until 1993, when small increases in the deficit begin to emerge. This pattern is due to the continuing changes in the economy's mix of inputs and outputs and in the level of economic activity. The interaction between changes in private savings and changes in the government deficit allow investment outlays to rise slightly through 1988, but restrict nominal investment expenditure from 1989 through 1995. However, the price of investment goods has fallen sufficiently to permit higher levels of real investment over the entire post-1985 period. Thus, in all years except 1982, capital availability is increased as a result of early and full decontrol of natural gas prices.

4.2 Changes in Productivity Conditions

4.2.1 Release of Resources from Gas Supply

Changes in the mix of natural gas supplies caused by the higher prices associated with accelerated decontrol can have one of two impacts on the economic resources used in domestic gas production. (In turn, each of these corresponds to different effects on productivity and real GNP.) It is possible that decontrol leads to the displacement of higher-cost gas alternatives within the overall supply mix. To the extent that this occurs, capital, labor, and other inputs are released from gas production, becoming available for use elsewhere in the economy. If there is a net release of economic resources from gas supply, these inputs can be reallocated to or used by other sectors, producing other types of output and thereby increasing the total volume of goods and services available in the economy. Since a larger total output is attainable from given factor inputs, overall productivity, output, and income are increased. But, it is equally possible that the configuration of supplies under decontrol will require a larger commitment of the economy's available resources. In this situation, there occurs a net absorption of resources into gas supply activities, implying a withdrawal of inputs from other uses. Such a reallocation imposes a cost on productivity and real GNP. As evidenced in Table 6, there is a net release of economic resources from domestic gas supply. At no time is there a productivity cost associated with the real resource effects of decontrol. In each year, 1982-1995, this aspect of gas price deregulation operates to increase overall productivity and the output potential of the economy. However, these benefits are significantly greater after 1986 than those secured over the period immediately following decontrol (1982-1985).

4.2.2 Changes in Imports and Exports

The effects of accelerated decontrol on foreign trade are shown in Table 15. Early deregulation has the following impacts on the energy component of trade. Gas exporters to the U.S. are assumed to adjust their prices so as to maintain the same markets as under present policy conditions (i.e., so as to maintain their export volumes). This results in small import price reductions for 1982, 1983, and 1984, large price declines in the period 1985-1986, and somewhat smaller and diminishing import-price reductions thereafter. The effect of this is to reduce gas import payments in all years. The Gas Market Model also predicts that decontrol leads to a net reduction in the demand for petroleum in the period 1982-1985, and small increases in liquids demand in the period 1986-1995. Accordingly, oil import payments are reduced through 1985 and increase thereafter. The combined impact of changes in oil and gas import conditions is to secure a reduction in energy import requirements in all years through 1988, after which the increase in payments for oil exceeds the reduction in gas payments.

However, energy is only part of the overall trade adjustment. In the period through 1984, accelerated decontrol results in higher domestic prices. This leads to some increase in import penetration in nonenergy markets. Even with this change, import payments are reduced, as imports are restructured away from energy and toward nonenergy. The resulting improvement in the balance of trade leads to adjustments in foreign currency markets, raising the value of the dollar against other currencies. This impacts U.S. exports, making them either more expensive and less attractive to foreign buyers, or less profitable to U.S. producers. Either way, there is some reduction in export quantities. Lower production for export releases economic resources for use in production to satisfy domestic demand. This rise in domestic consumption and investment possibilities is the economic benefit from the reduced outlays on imports.

For the 1985-87 period, there is still a small reduction in total import payments caused by decontrol. Correspondingly, there is a shift of resources to production for domestic purposes and a small rise in overall economic productivity. But, after 1988, the foreign trade adjustment imposes a cost on overall economic performance. The rise in total import payments, caused partially by the increases in economic activity, the rise in energy import payments, and the limited availabilities of primary inputs, sets in motion the opposite adjustments to those outlined above. There occurs an increase in export volumes required to sustain the higher import outlays. The additional production for exports diverts output, resources away from production for domestic markets, imposing a small cost on overall productivity.

Table 15

IMPACT OF FULL DECONTROL ON FOREIGN TRADE

(Change, Billions of 1972 Dollars)

	Real Imports			
Year	Energy	Nonenergy	Total	Total Real Exports
1982	-3.7	3.4	-0.3	-2.7
1983	-4.3	4.1	-0.2	-2.4
1984	-4.9	4.9	0.0	-2.1
1985	-2.8	2.7	-0.1	-0.5
1986	-1.6	1.6	0.0	-0.2
1987	0.0	0.0	0.0	0.0
1988	-0.1	0.1	0.0	0.1
1989	0.4	-0.4	0.0	0.2
1990	0.7	-0.7	0.0	0.3
1991	0.4	-0.4	0.0	0.2
1992	0.9	-0.9	0.0	0.3
1993	0.4	-0.6	-0.2	0.2
1994	1.3	-1.3	0.0	0.3
1995	1.3	-1.3	0.0	0.3

4.2.3 Changes in Input Patterns

Accelerated decontrol has a significant effect on the structure of input prices (Table 16). In turn, this is associated with a change in the composition of input quantities (Table 17). In the initial year of decontrol, there are significant increases in the prices for natural gas and other energy inputs. Producers respond by reducing the energy intensity of their production (subject to the gas-quantity restrictions from the DOE analysis) and increasing the relative intensities of capital, labor, and materials. Since capital services are limited by the beginning-of-year capital stock, the increase in capital intensity is comparatively small. Thus, growth in capital per worker is slowed which contributes to the productivity loss occurring in 1982. But, more importantly, the substitution toward capital and labor (the primary inputs to production) directly lowers productivity. More input of capital and labor per unit of output permits a reduction in energy use, but also implies that output per unit of capital and labor is diminished, i.e., the average productivity of capital and labor declines.

In the period 1982-1984, growth in capital and labor productivity and, hence, its level remain lower than under current policy conditions. While energy price growth is somewhat lower, there is a continuing decline in the energy intensity of production. Decontrol has led to higher investment, and accordingly, a higher capital stock. This now permits a shift to a more capital-intensive nature of production. Growth in capital per worker is increased, which improves overall productivity, and the rise in capital availability further enhances the energy-efficiency of capital. However, the productivity benefits of these changes are dominated by the productivity cost of the shift to a more capital-and labor-intensive input mix. Productivity growth is not as severely affected as in the initial year of decontrol but nevertheless, it remains slower under the conditions of accelerated deregulation.

In 1985, energy prices rise more rapidly under current policy conditions, thereby reducing the adverse productivity change in that year. (Recall that gas prices in 1985 and 1986 are actually lower than those of the Reference case.) There is a significant increase in average productivity growth or, more precisely, there is an avoidance of the productivity costs associated with partial decontrol in 1985. However, consistent with the patterns of relative price changes and factor availabilities, the rise in productivity growth is not sufficient to restore the average productivity of capital and labor to the level experienced with current policy. Thus, there is still a productivity loss associated with input restructuring.

Table 16

IMPACT OF FULL DECONTROL ON THE STRUCTURE OF RELATIVE INPUT PRICES

(Average Annual Rates of Change in Percent)

	1981-1982	1982-1984	1984-1985	1985-1995
Reference:				
Capital	9.68	7.79	7.92	6.12
Labor	10.97	9.74	10.56	8.86
Energy	9.86	8.56	21.37	7.64
Materials	7.40	6.11	7.22	4.93
Decontrol:				
Capital	9.50	7.40	7.71	6.18
Labor	10.97	9.74	10.56	8.86
Energy	18.64	8.48	11.58	7.59
Materials	7.78	6.00	6.78	4.94

Table 17

IMPACT OF FULL DECONTROL ON THE STRUCTURE OF INPUTS TO PRODUCTION

(Shares of Total Constant Dollar Inputs)

	1981	1982	1984	1985	1995
Reference:					
Capital	.1407	.1402	.1414	.1430	.1528
Labor	.2753	.2720	.2659	.2611	.2240
Energy	.0582	.0579	.0579	.0617	.0606
Materials	.5258	.5299	.5348	.5342	.5626
Average Annual Growth in:					
Capital per Unit Labor		0.84	1.58	2.99	2.22
Energy per Unit Capital		-0.15	-0.42	5.37	-0.84
Productivity of Capital and Labor*		1.68	1.03	1.04	1.10
Decontrol:					
Capital	.1407	.1404	.1424	.1439	.1533
Labor	.2753	.2727	.2661	.2603	.2236
Energy	.0582	.0555	.0555	.0618	.0607
Materials	.5258	.5314	.5361	.5340	.5625
Average Annual Growth in:					
Capital per Unit Labor		0.74	1.95	3.31	2.18
Energy per Unit Capital		-4.44	-0.70	10.19	-0.81
Productivity of Capital and Labor*		1.24	1.00	1.43	1.11

---

* Measured as the output-to-input productivity of capital and labor in producing total gross output (as distinguished from total final output or real GNP).

Finally, after 1985, energy price growth is again slower with the decontrol policy. Also, the decreases in the price of capital relative to that of labor are reversed. This change is the result of smaller increases in capital availability and smaller reductions in labor supply. Relative to the current policy situation, growth in capital per worker is slower, while average capital-labor productivity increases. On balance, these have a progressively favorable impact on the real output that is attainable from production, but productivity never fully recovers from the initial effects.

The output effects that result from this input restructuring can be summarized as follows. Higher gas prices to producers lead to a reduction in gas input which is associated directly with a reduction in output. This output effect occurs in all years except 1985 and 1986 (during which energy prices are actually lower under the conditions of decontrol), but principally over the 1982-84 period. In addition, changes in input prices and input patterns affect the average productivity of capital and labor in each producing sector and for the economy as a whole. These productivity changes arise from both direct and indirect causes. First, substitutions among capital, labor, energy, and materials impose an indirect productivity cost (and output loss), since these inputs are not perfect substitutes in production. Second, and more important, the substitutions of capital and labor directly lower productivity. Increasing the capital and labor intensity of production relative to other inputs corresponds to reducing the output that can be obtained for each unit of capital and labor input. Since the availability of primary inputs, i.e., capital and labor, is strictly limited, the reductions in their combined productivity lead directly to reductions in out-put. These losses occur in all years under accelerated decontrol, with the largest declines experienced over the period 1982-1984.

4.2.4 Changes in the Mix of Economic Outputs

The new relative price structure resulting from decontrol leads to changes in the composition of demand across the many producing industries. In addition, the changing disposition of final demand (between consumption investment, government, and exports) leads to a shift in the output mix between industries. Table 18 summarizes the sectoral impacts of changes in final demand. The relative shift from consumption to investment and, in the later years, to exports involves more output from agriculture, construction, and manufacturing and less output from services and energy. Similar patterns are observed in the structure of total U.S. production (Table 19). This change in output composition

Table 18

IMPACT OF FULL DECONTROL ON THE STRUCTURE OF FINAL DEMAND*

(Percent of Total Constant Dollar Final Demand)

	1981	1982	1984	1985	1995
Reference:					
Agriculture, Construction	13.79	13.77	13.64	13.63	13.26
Manufacturing	35.76	35.92	35.75	35.94	35.48
Transportation	3.45	3.45	3.48	3.47	3.57
Services	42.63	42.64	43.10	42.98	44.47
Energy	4.38	4.22	4.03	3.98	3.22
Decontrol:					
Agriculture, Construction	13.79	14.10	13.91	13.65	13.25
Manufacturing	35.76	36.16	35.94	35.94	35.46
Transportation	3.45	3.43	3.47	3.47	3.57
Services	42.62	42.35	42.88	42.97	44.49
Energy	4.38	3.96	3.80	3.97	3.23

---

* Purchases by households, businesses, governments, and the foreign sector (exports).

Table 19

IMPACT OF FULL DECONTROL ON THE STRUCTURE OF DOMESTIC PRODUCTION

(Percent of Total Constant Dollar Final Demand)

	1981	1982	1984	1985	1995
Reference:					
Agriculture, Construction	10.61	10.60	10.55	10.49	10.36
Manufacturing	41.95	41.90	41.75	41.52	40.51
Transportation	4.25	4.25	4.24	4.23	4.24
Services	36.41	36.60	36.94	36.96	38.57
Energy	6.78	6.65	6.52	6.80	6.32
Decontrol:					
Agriculture, Construction	10.61	10.81	10.73	10.50	10.36
Manufacturing	41.95	42.10	41.94	41.51	40.50
Transportation	4.25	4.24	4.24	4.23	4.24
Services	36.41	36.46	36.84	36.96	38.58
Energy	6.78	6.39	6.25	6.80	6.32

is of importance in its own right, signifying the impacts of decontrol across the whole production process. But also, these composition shifts have implications for overall productivity. Since different industries have different productivity levels and rates of growth, these compositional shifts in demand and production necessarily affect overall productivity. There are both productivity costs and benefits accompanying these sectoral changes. The restructuring away from energy entails a productivity benefit, since the energy industries have relatively low levels of capital and labor productivity. However, the shift toward construction that results from the greater relative importance of investment involves a productivity cost, given the comparatively low productivity of this sector. This, combined with similar, although smaller, effects elsewhere, leads to an adverse overall productivity impact resulting from the reallocation of economic resources. The output losses from these changes in productivity are largest for the period 1982-1984; these trends all but disappear after 1985 and, so, the magnitudes of the overall productivity losses and the output reduction associated with them are negligible.

4.3 Summary of Effects

The previous sections of this chapter have surveyed the major economic consequences of accelerated decontrol of natural gas prices. This section assembles and summarizes this information in terms of the effects, on real GNP, of each type of economic adjustment caused by decontrol.

Table 20 summarizes the types of effects and the time pattern and direction of the impact of the effect on real GNP. The first step is to separate the effects into two categories--those involving a change in the volume of capital and labor inputs, and those involving the output that can be secured from a given volume of capital and labor input. These effects involve factor input changes and productivity changes, respectively. The factor input changes generally work in opposite directions--less labor supply means less labor input and tends to reduce real GNP, while more investment means greater capital input which operates to raise GNP. The productivity effects are more numerous and more complicated. The incremental claim on economic resources of domestic gas supply is negative, i.e., it involves a release of economic resources and permits an increase in productivity. Also reduced import volumes due to decontrol generally operate to release resources from production for export and into production for domestic purposes, which favors output growth. Higher gas prices to producers work in the other direction, creating pressure to reduce energy input (in itself lowering output), as well as to shift toward capital and labor, lowering average productivity of these inputs. Finally, the shift in the mix of output between industries, in particular the structural shift associated with more investment, involves a slight reduction in average productivity.

Table 21 repeats the results of the decomposition of the real GNP effect from decontrol into the change due to factor inputs and the change due to productivity. In sum, the short term costs of accelerated decontrol are more due to productivity impacts, while the long term benefits of decontrol are more due to expanded supplies of factor inputs.

The factor input changes are shown in Table 22. There are small reductions in labor supply in all years. These cause some reduction in real GNP, although the magnitudes are small. The increase in investment due to decontrol is substantial over the 1982-84 period and continues to be positive in all years from 1985. More investment results in a higher capital stock and, from this, in higher GNP. The real GNP effect of this capital change reaches a maximum of 0.28% in 1985 and is still

Table 20

DIRECTIONS OF REAL GNP EFFECTS RESULTING FROM FULL DECONTROL

Mechanism	Real GNP Change
Change in Factor Inputs	
o Reduction in labor supply	- (all years, except 1982)
o Increase in investment, capital input	+ (all years, except 1982)
Change in Productivity	
o Net release of resources from domestic gas supply	- (all years)
o Reduction in exports in response to import changes	+ (1982-1987) - (1988-1995)
o Higher gas prices to producers	- (All years, except 1985 and 1986)
o More capital and labor input per unit of output in production	- (all years, but very small toward 1995)
o Shift of output mix toward lower productivity industries	- (1982-1984) negligible thereafter

Table 21

PRINCIPAL COMPONENTS OF REAL GNP EFFECTS OF FULL DECONTROL
(Real GNP change, percentage points)

	Change in Factor Inputs	Change in Productivity	Estimated Total Change
1982	0.01	-0.32	-0.31
1983	0.10	-0.34	-0.24
1984	0.18	-0.37	-0.19
1985	0.21	-0.08	0.13
1986	0.21	-0.04	0.17
1987	0.21	-0.03	0.18
1988	0.18	-0.02	0.16
1989	0.18	-0.01	0.17
1990	0.18	0.00	0.18
1991	0.16	-0.01	0.15
1992	0.15	0.02	0.17
1993	0.13	0.05	0.18
1994	0.12	0.04	0.16
1995	0.11	0.04	0.15

Table 22

EFFECTS OF LABOR AND CAPITAL CHANGES

	Change in Labor Supply %	GNP Impact of Labor Change %	Change in Investment %	Change in Capital Input %	GNP Impact of Capital Change %
1982	0.01	0.01	3.81	0.00	0.00
1983	-0.03	-0.02	3.28	0.32	0.12
1984	-0.05	-0.03	3.35	0.57	0.21
1985	-0.11	-0.07	0.41	0.79	0.28
1986	-0.10	-0.06	0.40	0.76	0.27
1987	-0.08	-0.05	0.31	0.72	0.26
1988	-0.09	-0.06	0.21	0.68	0.24
1989	-0.08	-0.05	0.20	0.64	0.23
1990	-0.07	-0.04	0.16	0.60	0.22
1991	-0.07	-0.04	0.11	0.56	0.20
1992	-0.07	-0.04	0.12	0.52	0.19
1993	-0.06	-0.04	0.03	0.48	0.17
1994	-0.06	-0.04	0.11	0.44	0.16
1995	-0.06	-0.04	0.07	0.41	0.15

at 0.15% in 1995. Thus, the analysis of the factor input change shows that the investment-capital effect of decontrol dominates the factor input response. In turn, this implies that the capital effect is the primary reason for the long term beneficial effects of decontrol and for the positive overall net benefit from this policy change.

The components of the productivity change are summarized as follows. The change in real resources to energy supply involves a productivity benefit (resource release). The import-export change is also significant and changes over time. The reduction in exports has a favorable productivity impact through 1987 but, from 1988 onward, increases in exports impose a productivity loss. Higher prices, and so less energy input to nonenergy production, involve an output loss. This loss is substantial in all except 1985 and 1986, but is most significant in the early years. Changed input patterns, involving the substitution of capital and labor cause a permanent adverse productivity effect. This effect is largest in the 1982-84 period, gradually diminishing after 1985. The altered mix of output is most important in the initial years, 1982-1984, when there is a relatively large shift to investment and to construction and manufacturing; from 1985, this effect is substantially less. These productivity changes suggest that several mechanisms and effects are important in explaining the productivity effects of decontrol. Most of these effects work in the same adverse direction over time; only the effects of resource changes in domestic gas supply and import-export changes after significant productivity benefits at some point.

The various conclusions on the real GNP impacts of accelerated natural gas price decontrol can now be summarized:

(1) Real GNP initially (1982-84) falls as a result of decontrol.

(2) This decline is mainly due to the adverse productivity effects.

(3) Beginning in 1985, real GNP is higher as a result of decontrol.

(4) This rise is due to the higher capital input that results from the higher levels of real investment permitted by decontrol.

(5) There are continuing adverse productivity effects of decontrol, but these are small and eventually yield to productivity benefits during the early 1990's.

5. MACROECONOMIC EFFECTS OF PHASED DECONTROL

This chapter summarizes the impact of accelerated phased natural gas price decontrol on future production and real incomes. Also, the economic mechanisms that bring about this change are examined. Overall economic performance is compared under current energy policy conditions, which include partial decontrol in 1985, and under a policy of phased deregulation leading to full decontrol in 1985. The information base for this assessment is a detailed analysis of the effects of this policy change on gas prices, gas and petroleum supply and demand patterns, production requirements for gaseous fuels, corporate and share holder earnings, and government revenues. This information is introduced into the Dynamic General Equilbrium Model (DGEM), providing estimates of the influence of decontrol on the growth and structure of the U.S. economy. The energy-economy modeling framework within DGEM accomodates all of the adjustment mechanisms contained in DOE's gas market assessment and, accordingly, the simulation offers a comprehensive economic evaluation of the changes arising from decontrol. A summary of the estimated macroeconomic impacts is given in Table 23.

As with full decontrol, phased decontrol of all natural gas prices yields a small net economic benefit. This benefit takes the forms of higher output and real incomes. Over the period of 1982 to 1995, the cumulative gain in real GNP is estimated to be $(1972) 21.4 billion (bn).

Using a 6 percent discount rate, the present value to 1981 of the real GNP changes through 1995 is calculated to be $(1972) 10.2 bn ($18.1 bn in constant dollars of 1980). However, the macroeconomic consequences of accelerated decontrol are relatively small. The cumulative, undiscounted gain in GNP over the fourteen year period is only 1.4 percent of the level of real GNP recorded in 1980.

Ultimately, both capital and labor share in the annual benefit of increased production, although the owners of capital experience the greater gains in real income. However, over the entire period 1982 to 1995, only the owners of gas-related capital secure a real income benefit. Real income to labor is projected to fall by a total of $(1972) 19.9 bn and the cumulative loss in other capital income is estimated to be $(1972) 12.0 bn. These reductions are more than compensated by an overall increase in gas-related capital income of $(1972) 53.3 bn. Thus, phased decontrol involves a relative shift of real income or purchasing power from the owners of labor services to the owners of capital services and, among the latter, from the owners of other capital assets to those having claims on the capital associated with domestic gas supply.

Table 23

Summary of the Macroeconomic Effects of Phased Decontrol
(Billions of 1972 dollars)

Changes from current policy situation in:

	Real GNP	Gross Income		
		Labor	Capital	
			Gas Related	Other
1982	-1.9	- 8.3	7.4	- 1.0
1983	-3.5	-14.4	12.6	- 1.7
1984	-3.8	-17.1	15.9	- 2.6
1985	2.2	0.0	2.7	- 0.5
1986	3.0	0.9	2.9	- 0.8
1987	2.9	1.6	2.1	- 0.8
1988	2.6	1.7	1.5	- 0.6
1989	2.9	2.0	1.5	- 0.6
1990	3.0	2.3	1.4	- 0.7
1991	2.6	2.1	1.1	- 0.6
1992	3.0	2.4	1.1	- 0.5
1993	2.4	2.0	0.8	- 0.4
1994	3.0	2.4	1.2	- 0.6
1995	3.0	2.5	1.1	- 0.6
Cumulative Effect	21.4	-19.9	53.3	-12.0
Net Present Value in 1981 at 6.0%	10.2	-23.8	42.7	- 8.

5.1 Economic Adjustments Under Phased Decontrol

The time pattern of the effects of phased decontrol is identical to that of full decontrol--short run costs followed by benefits in the medium and long runs. Output losses average $(1972) 3.1 billion for the first three years, 1982-1984. Reductions in labor income are even more significant, averaging $(1972) 13.3 billion for the same period, and are compensated only partially by increases in capital income. However, from 1985 onward, accelerated decontrol is beneficial. Output and income are somewhat higher than under current policy conditions and both capital and labor are recipients of this benefit. It is important to note however, that the projection horizon must be extended to 1989 before the early losses are offset by subsequent gains. It takes about seven years for the overall effects to become positive (in present value terms). The present value of the change in capital income is positive from the outset, but even by 19[illegible] the change in real labor income has a negative present value.

In a manner similar to full-decontrol the mechanisms that cause these output and income effects under phased decontrol arise from changes in the volume of capital and labor inputs and changes in productivity, i.e. the output that can be secured from a given volume of capital and labor input. Table 24 decomposes the real GNP effect of phased decontrol into the effect from changes in input quantities and that from changes in input productivity. The short term costs of decontrol are principally the result of productivity losses, while the expansion of capital inputs accompanied by productivity gains account for the longer-term benefits. These effects, though smaller in magnitude, were also observed in the simulation of full decontrol.

Table 25 summarizes the GNP effects of input changes. The input supply responses work in opposite directions. Labor supply falls slightly in all years after 1982. These reductions have a small, adverse impact on real GNP. Decontrol stimulates investment in all years. More investment results in a higher capital stock and, consequently, in higher real output. The investment-capital effect of decontrol dominates the total factor response. Greater capital availability provides the principal mechanism, securing both the long term and positive overall economic benefit.

Several mechanisms are important in explaining the productivity costs and benefits over time. Table 26 summarizes the GNP effects of these productivity changes. The incremental claim on economic resources for domestic gas production initially

Table 24

Principal Components of Real GNP Effects: Phased Decontrol
(Real GNP change, percentage points)

	Change in Factor Inputs	Change in Productivity	Estimated Total Change
1982	0.01	-0.13	-0.12
1983	0.04	-0.26	-0.22
1984	0.11	-0.34	-0.23
1985	0.15	-0.02	0.13
1986	0.16	0.02	0.18
1987	0.15	0.01	0.16
1988	0.15	-0.01	0.14
1989	0.14	0.01	0.15
1990	0.13	0.03	0.16
1991	0.12	0.01	0.13
1992	0.11	0.04	0.15
1993	0.10	0.01	0.11
1994	0.10	0.04	0.14
1995	0.09	0.04	0.13

Table 25

Effects of Labor and Capital Changes Resulting from Phased Decontrol (Percentage change from current policy case)

	Change in Labor Supply	GNP Impact of Labor Change	Change in Investment	Change in Capital Input	GNP Impact of Capital Change
1982	0.01	0.01	1.53	0.00	0.00
1983	-0.01	-0.01	2.40	0.13	0.05
1984	-0.01	-0.01	3.22	0.32	0.12
1985	-0.08	-0.05	0.50	0.56	0.20
1986	-0.07	-0.04	0.51	0.55	0.20
1987	-0.07	-0.04	0.34	0.54	0.19
1988	-0.07	-0.04	0.22	0.52	0.19
1989	-0.07	-0.04	0.21	0.49	0.18
1990	-0.06	-0.04	0.17	0.46	0.17
1991	-0.06	-0.04	0.11	0.44	0.16
1992	-0.06	-0.04	0.11	0.41	0.15
1993	-0.06	-0.04	0.05	0.38	0.14
1994	-0.05	-0.03	0.09	0.35	0.13
1995	-0.05	-0.03	0.05	0.32	0.12

Table 26

Directions of Real GNP Effects: Phased Decontrol

Mechanism	Real GNP Change
Change in Factor Inputs	
o Reduction in labor supply	- (all years except 1982)
o Increase in investment, capital input	+ (all years, except 1982)
Change in Productivity	
o Net release of resources from domestic gas supply	- (1982-1983) + (1984-1995)
o Reduction in exports in response to import changes	+ (1982-1986) - (1987-1995)
o Higher gas prices to producers	- (all years except 1985)
o More capital and labor input per unit of output in production	- (all years except 1995)
o Shift of output mix toward lower productivity industries	- (1982-1987) + (1988-1995)

harms productivity but, by 1984, altered gas supply and cost conditions release resources, thereby improving productivity. Changes in gas prices also contribute to this productivity pattern. Higher gas prices and the corresponding reduction in energy input involve a reduction in overall productivity. These are most acute in the 1982-1984 period but are smaller in subsequent years, following the small gas price differentials from 1985. The relative price changes arising from the new policy cause a rise in the capital and labor intensities of production. This lowers the average productivity of these inputs, with especially strong effects in the early years. The restructuring toward capital and labor gradually slows so that, by 1995, average capital-labor productivity is actually higher than with current policy. Output restructuring exhibits a similar time pattern with regard to productivity. Early structural changes associated with more investment, for example the increased relative importance of construction, involve a productivity cost, whereas the structural changes from 1988 onward secure improvements in productivity. Finally, the effects of changes in import and export patterns work to offset other productivity trends. In the early years (1982-1986), reduced import payments permit the release of resources from export production. These become available for use in the production supporting domestic demand, thus raising productivity. However, from 1987 onward, increased exports divert resources and, so, impose a productivity cost.

5.2 Phased Decontrol Compared to Current Policy

In comparison to current policy, the conclusions regarding the real GNP impacts of accelerated phased decontrol, with full deregulation in 1985, are:

1) Real GNP initially (1982-1984) falls as this policy is introduced.

2) These early losses are due primarily to the adverse effects on economic productivity.

3) From 1985 onward, real GNP is higher under this policy.

4) This rise is due to the higher capital input that results from the higher levels of real investment.

5) The adverse productivity effects of decontrol give way, beginning in 1986, to small but positive productivity benefits.

5.3 Phased Decontrol Compared to Full Decontrol

In comparison to full decontrol in 1982, the effects of phased decontrol (with full decontrol by 1985), can be summarized:

1) Both immediate decontrol and phased decontrol, when compared to the present natural gas policy, cause economic damages over the 1982-1984 period and economic benefits thereafter.

2) Full decontrol in 1982 involves a large GNP reduction in that year, with successively smaller losses in 1983 and 1984. The reverse is true under the phased decontrol.

3) The average economic loss incurred during the years 1982-1984 is greater when full decontrol occurs in 1982 rather than 1985.

4) The economic benefits incurred over the 1985-1995 period are generally greater when full decontrol occurs in 1982 rather than 1985.

5) The comparison between immediate and phased decontrol involves the trade-off between larger initial losses with greater long-term benefits (immediate decontrol) and smaller initial costs but smaller overall benefits (phased decontrol). Thus, the macroeconomic comparison between these two decontrol policies depends critically on the discount rate.

6) The time pattern of economic impacts reflects those of gas price changes and real resource effects. In each year, it is generally the case that the policy favoring one of these parameters, e.g., lower gas prices, appears at a disadvantage in the other dimension, e.g., higher gas costs. Hence, there are opposing forces operating on real GNP, as seen below.

Period	Phased Decontrol by 1985 Versus Full Decontrol in 1982
1982-1983	Gas prices lower, real resource effects higher, GNP loss smaller.
1984	Gas prices higher, real resource effects higher, GNP loss greater.
1985-1988	Gas prices higher, real resource effects lower, GNP benefit generally smaller.
1989-1995	Gas prices lower, real resource effects generally higher, GNP benefit smaller.

ANNEX

SUMMARY OF THE DYNAMIC GENERAL EQUILIBRIUM MODEL

The Dynamic General Equilibrium Model (DGEM) is a simulation model of the structure and growth of the U.S. economy. It combines a model of macroeconomic growth with a multisector, input- output model based on flexible coefficients. For each year, it models economic activity on a sectoral basis and integrates these into a consistent whole. There are nine producing sectors--five are energy-related and the remainder are nonenergy producers:

- Agriculture, nonfuel mining, construction;
- manufacturing (nonenergy);
- transportation;
- communications, trade, services;
- coal mining;
- crude petroleum and gas extraction;
- refined petroleum products;
- electric utilities;
- gas utilities.

New technology energy supply, conversion, and end-use activities are included explicitly under five categories:

- Coal supply and demand substitutes;
- petroleum supply and demand substitutes;
- electricity supply substitutes;
- electricity demand substitutes;
- gas supply and demand substitutes.

New energy sources first are specified in detail and, then, are aggregated into these five categories (see Table A.1). Inputs into production and final demand purchases are provided by the

Table A.1

TECHNOLOGICAL DETAILS OF ENERGY PRODUCTION AND CONSUMPTION WITHIN DGEM

Displacement of:	With:
Conventional Coal Supply and Demand	Biomass Resources
	Direct Biomass to Industry
	Geothermal Process Heat
Conventional Petroleum Supply and Demand	Oil from Shale
	Coal Liquids
	Biomass Liquids
	Solar/Oil Space Heat
	Solar/Oil Process Heat
	Geothermal Process Heat
	Direct Biomass to Households
	Direct Biomass to Industry
Conventional Central Station Electricity Supply	Advanced Coal Systems
	Low-head Hydroelectric
	Nuclear
	Geothermal Electric
	Biomass Electric
	Solar Thermal Electric
	Centralized Wind
	Centralized Photovoltaics
Conventional Electricity Demand	Decentralized Wind
	Decentralized Photovoltaics
	Solar/Electric Heating and Cooling
	Solar/Electric Water Heat
Conventional Gas Supply and Demand	Medium Btu Gas from Biomass
	Medium Btu Gas from Coal
	High Btu Gas from Coal
	Solar/Gas Water Heat
	Solar/Gas Process Heat
	Direct Biomass to Households

nine main producing sectors. In addition, there are three other sources of inputs to the economy (capital, labor, and competitive imports) and four categories of final demand for goods and services (personal consumption expenditures, investment, government purchases, and exports). These activities are organized into a matrix of interindustry transactions with twelve supply sectors and eighteen purchasing sectors.

A projection from DGEM presents a dynamic-equilibrium view of the U.S. economy. Balance or consistency is required to hold in several senses. First, price formation must be such that sectoral output prices cover average production costs, including a normal rate of return. Second, sectoral output quantities must match exactly the quantity of that good or service required for input into production together with the amount used to satisfy final demand. Third, prices and quantities must be such that the revenue received by a sector are exhausted totally by payments to inputs, including income to capital, and payments to governments. Fourth, the demands for labor and capital must be consistent with the supplies of these resources, the former being determined within the context of household behavior, i.e., labor-leisure choice, and the latter being determined through a dynamic saving-investment mechanism.

Activity patterns within DGEM are represented by econometric submodels. Also, the production requirements for new energy sources are integrated into the overall structure through use of technological, i.e., fixed-coefficient, submodels. The econometric submodels for each of the conventional producing sectors incorporate the patterns of behavioral and technical responses observed for these activities. Collectively, these submodels provide the framework for analysis of output price formation and, with the aforementioned balance conditions, determine the system of relative prices within the economy. The submodels also determine the particular pattern of input purchases that minimize production costs given prevailing prices. Thus, input-output coefficients and sectoral productivities are endogenous, being functions of relative prices and price-induced technological change. Similarly, the pattern of consumption spending is modeled in a flexible manner. These features provide for the incorporation of economic behavior, substitution or complementarity relationships between inputs, and the nature of adjustment in the pattern of consumer expenditure.

As a result, some of the principal adjustment mechanisms in the economic system are explicitly incorporated in the model. For energy, these features incorporate the analysis of the patterns of use of energy as an input to each type of production as well as the patterns of energy use in consumption and other final demand activities. For the economy in general, this specification provides for the incorporation of a full supply representation of production, including input requirements, input constraints, input adjustment possibilities and productivities. Further, the general equilibrium specification ensures that the direct and indirect effects throughout the economy of energy (or other) changes are accommodated.

Simulations from DGEM reflect the patterns of desired expenditure that are consistent with what is achievable from production, i.e., the supply possibilities of the economy. Therefore output is dependent on input availabilities, sectoral rates of productivity growth and production requirements, and their combined implications for total factor productivity. In each period, input prices in conjunction with the supply of inputs determine incomes, which primarily are composed of incomes to capital and labor. Incomes together with prices, wealth, rates of return, and other influences, determine expenditure. Final spending and interindustry input patterns, also reflecting relative prices, determine total industry outputs and, so, demands for inputs. If demand and supply quantities are not equal in both product and factor markets, then prices and rates of return adjust so as to achieve equilibrium. Over time, the saving-investment mechanisms influence the productive potential of the economy through their effects on wealth and capital accumulation. The balance between saving and investment determines the rate of return and the rate of growth of the capital stock, i.e., investment in each period establishes the availability of capital in the following period. The resulting projection has the following features:

- Final demand expenditure on each type of good or service that reflects income, prices, and other determinants;

- levels of real economic activity that are feasible in terms of the supply and demand positions of each sector and, so, of the economy;

- a relative price structure that is consistent with demand, supply, and resource configurations;

- a supply position that reflects both patterns of inputs and productivities in each sector and, through time, the availability of these inputs and resources to the economy.

- economic growth as a sequence of one-period equilibrium giving demand, supply, and the relative price for each commodity and factor.

ATTACHMENT II

THE ECONOMIC EFFECTS OF ACCELERATED DECONTROL BASED ON DRI MODEL SIMULATIONS

Prepared by:

MTSC Division
Scientific Time Sharing Corporation

Rockville, MD 20852

OVERVIEW

The Natural Gas Policy Act of 1978 (NGPA) provides for decontrol of the wellhead price of most gas in 1985. Attention has recently focused on altering the provisions of the NGPA, by accelerating the decontrol of natural gas and lifting wellhead price restrictions from all categories of gas. These changes have been suggested as a means to increase the supply of natural gas produced domestically, increase the efficiency of its use in the economy, and reduce the level of U.S. oil imports.

Changes in the pricing policy of natural gas may have "major" economic impacts.[1] To assess the likely economic effects of accelerated decontrol, DOE has used several models of the U.S. economy, including models constructed by Dale Jorgenson/Edward Hudson, Wharton, and Data Resources, Inc. (DRI). These models provide forecasts of key economic variables, such as real GNP, prices, and inflation, based on a set of econometrically estimated equations which attempt to explain how certain, endogenous, economic variables change in response to assumed, or exogenous, variables such as population changes or fiscal policies. By varying exogenous variables - in this case, natural gas supply, demand, and price variables - estimates of changes in other economic measures are derived.

This paper reports the findings derived from using the DRI model and documents the analytical approach used in preparing a forecast from the model. It is divided into three parts:

- In Section 2, an overview of the analytical approach used to prepare impact estimates is presented;
- In Section 3, the results from the simulations are presented and discussed; and,
- In Section 4, shortcomings in the analysis are identified.

In addition, an appendix is included which provides details on specific changes made to the DRI model to simulate the effects of accelereated natural gas decontrol.

---

[1] Executive order 2030 defines "major impacts" by criteria such as economic costs over $100 million per year, or major increases in costs or prices for individual industries.

It should be clear that our ability to forecast the future is highly limited. Many exogenous variables, such as the course of future monetary policy or the price of imported crude oil, are not known with any level of certainty. Even if they were, changes in the way consumers and investors behave may be changing; these are not captured well within models of the type used in this analysis. And, most importantly, the structure of the models may be incapable of incorporating the most important effects of a policy change, such as the efficiency gains which accrue to the economy due to accelerated decontrol of gas. Hence, the economic effects discussed here should be thought of as illustrative, rather than definitive, estimates of the impacts of natural gas pricing policies on the economy.

ANALYTICAL APPROACH

To prepare estimates of the impacts of natural gas pricing policies on the economy, this analysis uses the short-term quarterly forecasting model developed by Data Resources, Inc. (DRI). The DRI model is a large-scale econometric model with over 900 equations. It can be generally characterized as Keynesian in nature. Emphasis is placed on forecasting levels of economic activity (GNP, etc.) by accounting for key determinants of aggregate demand, such as incomes, interest rates, and prices. In recent years, increased attention by DRI has been placed on incorporating some "supply-side" concepts into the model's framework. The model's framework, however, is distinctly oriented towards short-term forecasting using Keynesian concepts. As will be discussed later, this orientation restricts its capabilities to accurately reflect the expected effects of accelerated decontrol.

The "base case" used in this analysis, is a model simulation which assumes that natural gas pricing provisions of the NGPA are maintained throughout the next decade. It was developed by modifying a recent DRI model simulation entitled "OPTIMLONG2006". OPTIMLONG2006 is a DRI-developed long-term forecast of the economy incorporating economic assumptions which are generally consistent with those of the President's Program for Economic Recovery.

Adjustments to OPTIMLONG2006 to develop the REFCUR85 model simulation principally involved adjusting values of energy price, demand, and supply variables to make them consistent with internal DOE assumptions. In brief, these included adjusting natural gas variables, such as the price and quantity consumed of natural gas by the residential sector, and other energy price variables, such as the price of imported crude oil and the price of electricity. In general, the changes made to the model to develop the REFCUR85 simulation produced negligible differences from the economic forecast embodied in OPTIMLONG2006.

To assess the impacts of the effects of accelerated natural gas decontrol, a second simulation, entitled REFFUL82, was in turn developed using the model. Changes in the value of specific variables in the model were introduced to reflect DOE assumptions on the effects of accelerated decontrol in 1982. Specific variables in the DRI model which were modified in the REFFUL82 simulation included:[1]

- The producer price index for gas fuels (WPI053)

---

[1] Items in parenthesis are the relevant DRI variables which correspond to DOE concepts. In several cases, the values of these were adjusted by changing the "add factors" associated with these variables. This is further discussed in Appendix A.

- The implicit price deflator - personal consumption expenditures for natural gas (PCSHHOPG)
- The producer price index for electricity (WPI054)
- The unit value index - fuel imports (JMEND10)
- Industrial production index - oil and gas (JQIND13)
- Fuel imports (MEND1067)
- Real personal consumption expenditures for natural gas (CSHHOPG72)
- State and local severence taxes (TXGSL)

The specific techniques used to adjust these are discussed in Appendix A.

The above-mentioned variables are the principal ones incorporated into the current version of the DRI model to estimate the impacts of natural gas pricing policies. While the number of changes is numerous, it is by no means complete. Many natural gas-specific variables considered by DOE, such as the price and quantity consumed of gas in the commercial and industrial sectors, or price differentials between the inter and intrastate gas markets, are not explicitly considered in the DRI model. This lack of specificity limits the model's capability to accurately assess the economic effects of natural gas decontrol.

Perhaps the most important concept not explicitly considered in the DRI model, but extremely relevant in any analysis of natural gas pricing, is the effect of decontrol on "real-resource costs." Although accelerated decontrol is likely to increase the costs of natural gas to current users, increases in the efficiency of allocation of gas among all energy-consumers may result in a net decline in costs. For example, as residential users conserve gas, this gas can, in turn, be redirected to industrial users who, prior to accelerated decontrol could not obtain all of the natural gas that they desired. Although the price they pay for gas may increase, industrial users' "net costs," or the combined cost of all energy, may actually decline. This net resource gain represents a tangible benefit to these users, and the economy, which must be considered in any economic impact analysis.

In the DRI model, however, any net resource gains from accelerated decontrol will not be captured unless other adjustments to model variables are made. To estimate energy costs and their effects on industrial and final prices, the model uses equations with fixed coefficients based on input/output techniques. For example, the producer price index for metals and metal products (WPI10) is calculated by assuming that 1.7% of the costs of metals production is due to natural gas prices. This percentage will not change with accelerated decontrol, nor will the shares attributed to petroleum, coal, and electricity prices change. The effects of accelerated decontrol will thus be overstated.

To adjust for the net resouce gains in the REFFUL82 simulation, estimates of these gains were reflected in the model by altering the value of potential GNP (GNP72FE). Potential GNP is a measure of the productive capacity of the economy to produce goods and services if labor were fully employed. A policy such as accelerated decontrol, by increasing the real energy resources available for production, increases aggregate production capacity. Internal DOE analysis provided estimates of the level of net resource gain to be used for this adjustment.

Given the adjustment to potential GNP, along with changes to natural gas-specific variables, the model was solved. Differences in the economic forecasts between the REFCUR85 and REFFUL82 simulations are taken to be the effects on the economy atributable to accelerated decontrol.

Alternative Simulations

In addition to the two macroeconomic simulations described above, four alternative simulations were prepared to examine the sensitivity of the impact estimates to various assumptions. The four alternative simulations include experiments with assumptions concerning the speed of decontrolling natural gas prices, the effect of efficiency gains, and fiscal policy.

A simulation entitled "NAIVE" was prepared to test the sensitivity of the REFFUL82 simulation to adjustments made for real resource gains. In this simulation, all variable changes incorporated in REFFUL82 are maintained with the exception that the adjustment to potential GNP is not made. By comparing the results of this simulation with the results of REFFUL82, the impact of the real resource adjustments can be isolated.

Two simulations were prepared to test the sensitivity of REFFUL82 to fiscal policy initiatives. In the REFFUL82 case, no changes in Federal fiscal policy were assumed. This was reflected in the simulation by holding real government spending constant and by introducing no changes to the tax code. In the alternative simulations, adjustments to fiscal policy were made to hold the Federal deficit at the same level as in the REFCUR85 simulation. The two cases include:

1. GOVTSPEND - where changes in government spending on non-defense goods and services are made to hold the deficit constant; and,
2. TAXCUT - where changes in personal tax rates are made to hold the deficit constant.

A fourth simulation entitled "PHASED" was prepared to test the sensitivity of the economy to the rate at which natural gas prices rise. In this simulation gas prices rise more steadily than in the REFFUL82 case, although they do eventually rise to the same levels.

The results of these simulations, as well as the results from the REFFUL82 and REFCUR85 simulations, are reported in the next section.

RESULTS

This section describes the results from the DRI model simulations of accelerated decontrol. In addition to presenting economic impact estimates, it qualitatively explains the basis for the direction and magnitude of each of the effects. First, in Sections 3.1 through 3.3, a comparison of the impacts of accelerated decontrol, based on the REFFUL82 simulation, is presented. Following this, Section 3.4 discusses the sensitivity of these estimates as simulated in the atlernative simulations.

3.1 The Impacts of Accelerated Decontrol - REFFUL82 Case

The results from the two DRI model simulations, accelereated decontrol (REFFUL82) and current policy (REFCUR85), suggest that gas decontrol in 1982 may have significantly adverse effects on the economy in the short-term (1982-84), distinctly positive effects in the mid-term (1985-1987), and mixed effects thereafter.

Table 3-1 summarizes differences between the two simulations for three key economic variables; real GNP, price inflation (measured using the implicit price deflator for GNP), and the unemployment rate. In the years 1982 through 1984, higher prices of natural gas increase the rate of inflation, adding 1.4 percentage points to inflation in 1982, 0.7 percentage points in 1983, and 0.1 percentage points in 1984. The effect of these increases is to reduce real GNP by $5.0 billion (1972 dollars) in 1982, $10.0 billion in 1983 and $7.4 billion in 1984. In the mid-term (1985 through 1987), gas prices in the REFFUL82 simulation rise considerably slower than in the REFCUR85 simulation; inflation is reduced by 0.9 percentage points in 1985 and by 1987 the price level in the REFFUL82 simulation falls to within 0.5 percent of the level in the REFCUR82 simulation. From 1985 to 1987, reduced levels of inflation in REFFUL82, together with real resource gains attributable to accelerated decontrol, increase real GNP relative to the REFCUR85 case by $7.5 billion (1972 dollars). After 1987, the simulations show mixed effects; inflation is slightly lower in the REFFUL82 case, GNP is slightly lower, and unemployment is slightly higher.

3.2 Impacts on the Price Level

The DRI simulations indicate that accelerated decontrol of gas prices will have significant impacts on the aggregate price level, as measured by increases in the Consumer Price Index - All Urban Consumers (CPIU) and the GNP delfator. Increases in the price of natural gas between 1982 and 1984 directly affect the rate of inflation in two ways:

TABLE 3-1

Comparison of Key Economic Variables
REFCUR85 versus REFFUL82

	1982	1983	1984	1985	1986	1987	1988	1989	1990	Cumulative Difference
REAL GNP (1972$)										
REFCUR85	1566.6	1648.1	1722.4	1787.5	1859.3	1942.2	2008.7	2064.0	2112.6	
REFFUL82	1561.6	1638.1	1714.9	1789.9	1866.1	1940.5	2007.3	2061.3	2108.8	
Difference	- 5.0	- 10.0	- 7.4	2.4	6.8	-1.7	- 1.4	- 2.7	-3.8	-22.8
RATE OF CHANGE GNP Deflator (%)										
REFCUR85	8.4	7.2	5.9	5.9	4.0	4.1	4.7	4.4	4.4	
REFFUL82	9.8	7.9	6.0	5.0	3.1	4.2	4.8	4.3	4.3	
Difference	1.4	0.7	0.1	- 0.9	- 0.9	0.1	0.1	- 0.1	- 0.1	0.4
UNEMPLOYMENT RATE										
REFCUR85	7.3	6.6	6.1	5.8	5.7	5.3	5.1	5.1	5.2	
REFFUL82	7.4	6.8	6.3	5.8	5.6	5.2	5.0	5.1	5.3	
Difference	0.1	0.2	0.2	0.0	- 0.1	- 0.1	- 0.1	0.0	0.1	0.3

---

* Differences may not add correctly due to rounding

1. Increases in gas prices to consumers affect the CPIU directly. Natural gas purchases constitute over 1.0% of the CPIU. Therefore, a 40% increase in gas prices to consumers in 1982 (as in REFFUL82 case) directly adds 0.4 percentage points to the CPIU.
2. Increases in gas prices to producers affects the producer price index (PPI) directly. Natural gas prices (inter and intrastate) constitute 1.3% of the PPI-all commodities. Therefore, an 85% increase in wellhead prices raises the all commodities index by about 1.1 percentage points.

In addition, increases in gas prices indirectly raise prices in several ways:

1. Producers will attempt to pass through increased costs to consumers. To the extent they are successful, prices of products which embody natural gas - particularly natural gas-intensive products and services - will rise.
2. With higher inflation, workers will attempt to maintain their former level of real purchasing power by seeking higher wages. To the extent they are successful, increased labor costs will further contribute to inflation.
3. If the short-term impact of gas decontrol results in lower productivity, this, in turn, will put upward pressure on inflation.

While the short-term inflation effects of natural gas decontrol are likely to be adverse, the longer term effects will not be. In 1985, natural gas prices in the REFCUR85 simulation rise considerably, approaching a level almost identical to that found in the REFFUL82 case. These increases should offset the short-term effects of accelerated decontrol. In the longer term, where gas prices are relatively unchanged between the two cases, but where efficiency gains are larger with accelerated decontrol, price effects should be favorable.

The results from the DRI model are generally consistent with this reasoning. Figure 3-1 shows the percentage change in the wellhead price of natural gas, the residential price of gas, and the change in the CPIU in the REFFUL82 case relative to the REFCUR85 simulation. In the early years, increases in gas prices contribute to increased inflation. After 1985, declines in the rate of increase of gas prices serve to reduce inflation, and from 1987 to 1990 the rates of inflation are virtually identical (see Figure 3-2).

3.3 Impacts on Gross National Product

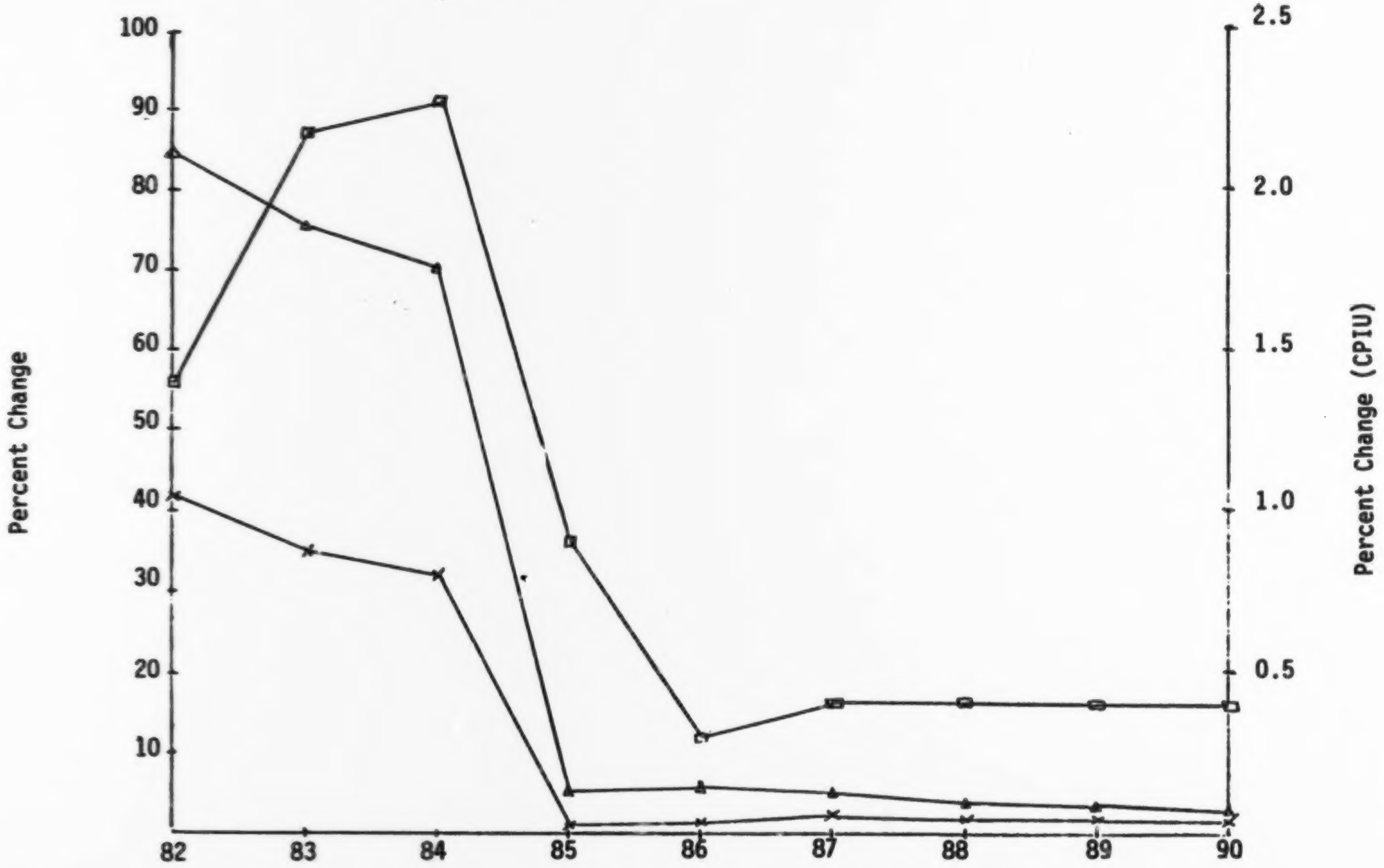
The DRI simulations indicate that decontrol of gas prices will have a negative impact on real GNP in the short-run. The magnitude of these impacts is shown in Table 3-1 (in dollar terms) and in Figure 3-3 (in percentage terms).

Changes in real GNP due to decontrol follow a pattern similar to the increases in prices - decontrol leads to losses as prices rise and gains as prices fall. Between 1982 and 1984, cumulative GNP losses total $22.8 billion (1972$). In

FIGURE 3-1

Percent Change in Gas and Consumer Prices

REFFUL82 VERSUS REFCUR85

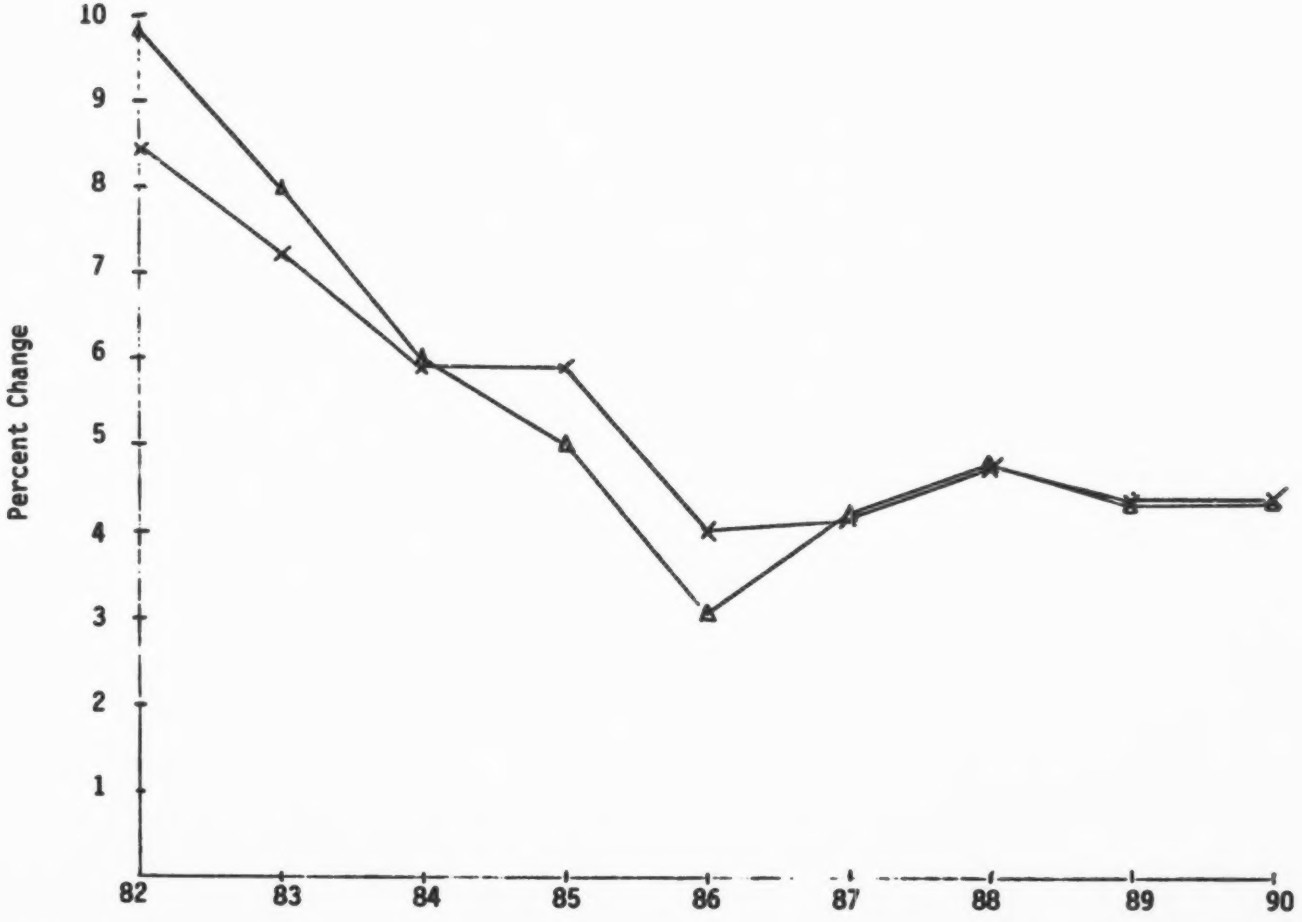


	82	83	84	85	86	87	88	89	90
△ Wellhead	84.6	76.4	70.1	4.5	4.6	4.2	3.3	3.1	2.8
× Residential	42.2	35.8	32.2	0.5	1.0	2.7	1.9	2.1	2.0
□ CPIU	1.4	2.2	2.3	0.9	0.3	0.4	0.4	0.4	0.4

FIGURE 3-2

Annual Rates of Change in GNP Deflator

REFFUL82 VERSUS REFCUR85



	82	83	84	85	86	87	88	89	90
△ REFFUL82	9.8	7.9	6.0	5.0	3.1	4.2	4.8	4.3	4.3
✕ REFCUR85	8.4	7.2	5.9	5.9	4.0	4.1	4.7	4.4	4.4

the years 1985-1987, cumulative GNP gains total $19.4 billion. Over the entire period, the cumulative loss in real GNP is $34.8 billion. In terms of the overall size of GNP during the period, this loss is slightly over one tenth of one percent.

The impacts of decontrol on real GNP represent the sum of the individual impacts on total consumption, investment, government spending, and net trade. Each of these will be discussed in turn:

3.3.1 Impacts on Consumption

The DRI simulations suggest that accelerated decontrol will adversely affect real consumer spending in the short-term, but will lead to increases in the years following these short-term effects.

In the early years, real consumer spending changes are small, with the largest decline occurring in 1983 (see Figure 3-3). Declines in spending are due to several factors. First, wages fail to increase as fast as increases in inflation, leading to declines in incomes. Second, even though real wage gains do not keep up with inflation, nominal wages do increase, pushing taxpayers into higher marginal tax brackets, and further reducing real disposable incomes. Finally, the real value of financial assets held by households, such as bond holdings, are reduced by inflation.

By 1985, the effect of decontrol on consumer spending is reversed. Lower rates of inflation permit households to maintain, and, in fact, increase, their real after-tax incomes. Similarly, gains in the value of household assets increase their purchasing power. In addition, those purchases which consumers "deferred" are made, such as the replacement of autos and furniture. Together these effects lead to increases in real spending throughout the 1985-1988 period.

3.3.2 Impacts on Investment

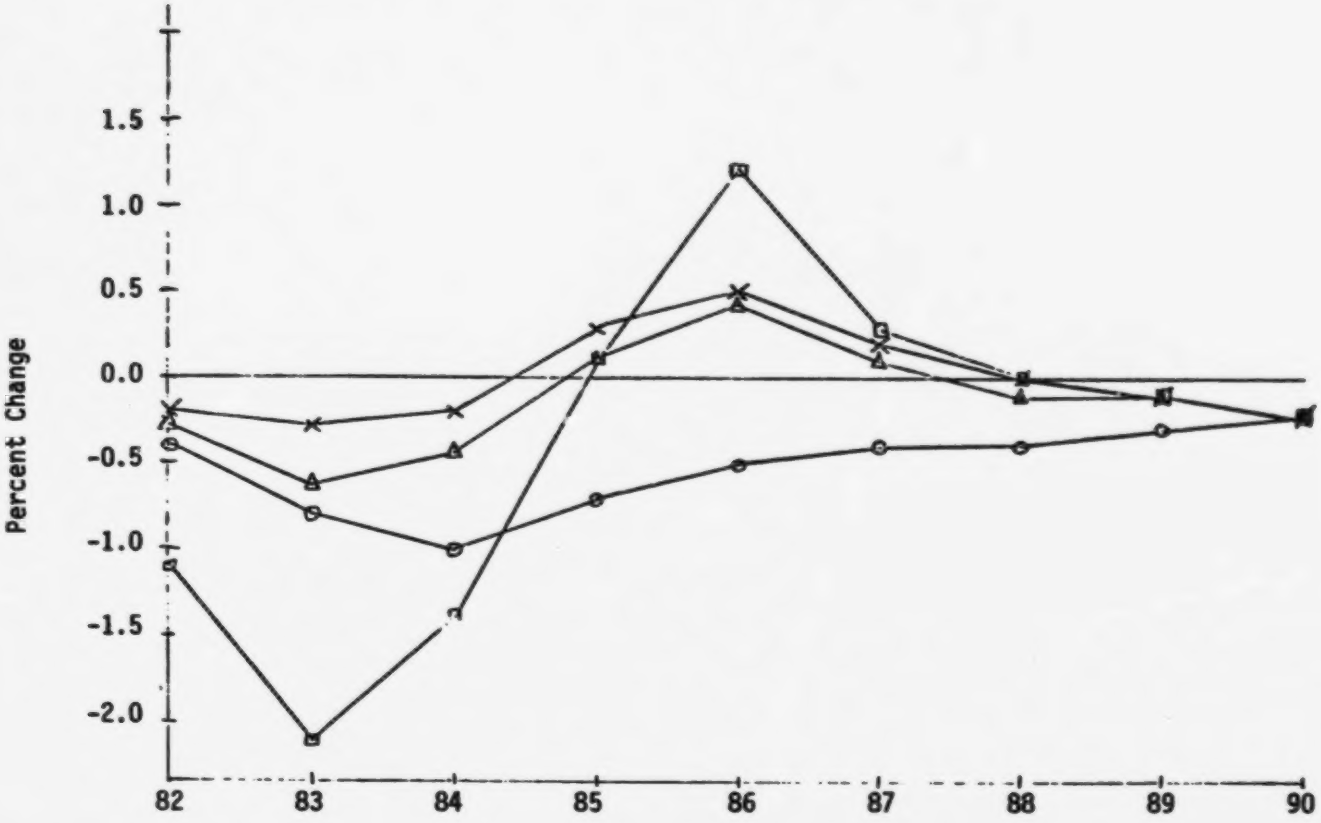
In the DRI simulations the largest impact of accelerated decontrol occurs in real investment expenditures, as shown graphically in Figure 3-3. Investment spending is adversely affected in the early years by several factors. First, declines in output reduce the utilization of the existing stock of plant and equipment, making the need for additional plant and equipment less desirable. Second, inflation-induced increases in tax rates businesses pay, due to the treatment of inventory profits and depreciation on a historical cost basis, reduce the level of internal funds available, and thereby raise the cost of financing new investment by forcing investors to rely on outside financial sources. Finally, higher rates of inflation serve to increase interest rates, raising the cost of capital and lowering investment expenditures on interest-sensitive categories such as residential investment.

99

FIGURE 3-3

Changes in Components of Real GNP

REFFUL82 VERSUS REFCUR85



	82	83	84	85	86	87	88	89	90
△ Real GNP	-0.3	-0.6	-0.4	0.1	0.4	0.1	-0.1	-0.1	-0.2
× Consumption	-0.2	-0.3	-0.2	0.3	0.5	0.2	0.0	-0.1	-0.2
□ Investment	-1.1	-2.1	-1.4	0.1	1.2	0.3	0.0	-0.1	-0.2
○ Exports	-0.4	-0.8	-1.0	-0.7	-0.5	-0.4	-0.4	-0.3	-0.2

After 1984, investment spending recovers and exceeds base case levels. Interest rates begin to come down and these reductions in the cost of capital increase the incentive to invest. Capacity utilization of the existing stock of capital also picks up after 1984 which raises the need for newer equipment and more plants. Finally, investment projects which were postponed in earlier years (for reasons already discussed) are undertaken. By 1986, the percentage increase in investment, relative to base case levels, exceeds those of all other major components of GNP.

3.3.3 Impacts on Net Trade

Several diverse effects contribute to changes in the real trade balance which are generally negative throughout the period. The increases in the prices of U.S. goods relative to foreign goods due to natural gas price increases adversely affects U.S. exports to other nations and increases the demand for imports domestically. Slower economic growth in 1983 and 1984, however, reduces U.S. import demand. Finally, declines in oil imports due to increased use of gas reduces U.S. imports of fuels. On balance, the change in net trade is small.

3.3.4 Impact on Employment

The DRI simulations show that changes in the level of employment resulting from gas decontrol follow a pattern similar to changes in the level of real GNP. Unemployment rises as total output and aggregate demand declines. By 1983, the unemployment rate is up 0.2 percentage points, a loss of about 300,000 jobs. As the economy recovers, employment follows this trend. By 1987, the unemployment rate falls 0.1 percentage points below the REFCUR85 level, and the number of employed has increased by about 200,000.

3.4 Alternative Simulations

The results from the REFFUL82 simulation indicate that accelerated decontrol of natural gas may have pronounced impacts on prices, GNP, and employment. These results, however, are conditional on numerous assumptions, including the treatment of real resource gains, the course of fiscal policy, and the rate at which natural gas prices are decontrolled.

Four simulations test the sensitivity of these assumptions. Summary results are shown in Table 3-2, and Figure 3-4 displays graphically the percentage change in real GNP from the REFCUR85 simulation.

3.4.1 NAIVE Simulation

In this sensitivity case, the adjustment introduced to potential GNP in the REFFUL82 case is not made. As indicated in Table 3-2, the adjustment made in the REFFUL82 simulation does not affect the pattern of the change in real GNP or inflation. It does, however, affect the absolute

TABLE 3-2

CHANGES ON THE KEY ECONOMIC VARIABLES IN THE ALTERNATIVE SIMULATIONS (Relative to Current Decontrol Policies)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	Cumulative Difference
CHANGE IN REAL GNP (72$)										
REFFUL82	- 5.0	- 10.0	- 7.4	2.4	6.8	1.7	- 1.4	- 2.7	- 3.8	- 19.4
NAIVE	- 5.1	- 10.4	- 8.6	0.7	5.4	- 0.3	- 2.8	- 4.2	- 5.5	- 30.8 -30.8
GOVTSPEND	5.1	- 3.6	- 5.6	1.5	14.2	11.8	4.3	- 4.1	- 12.3	11.3
TAXCUT	- 1.3	- 6.3	- 5.9	3.1	11.4	8.2	3.5	- 1.0	- 5.6	6.1
PHASED	- 0.5	- 3.7	- 8.7	- 5.2	3.5	4.3	0.9	- 0.1	- 0.6	- 10.2
ADDITION TO INFLATION RATE - GNP DEFLATOR (%)										
REFFUL82	1.7	0.7	0.1	- 0.9	- 0.9	0.2	0.1	- 0.1	- 0.1	0.8
NAIVE	1.5	0.8	0.2	- 0.9	- 0.8	0.1	0.1	- 0.1	- 0.1	0.8
GOVTSPEND	1.5	0.8	0.2	- 0.9	- 0.8	0.3	0.2	- 0.1	- 0.1	1.1
TAXCUT	1.5	0.8	0.1	- 0.9	- 0.9	0.2	0.2	0.0	- 0.1	0.9
PHASED	0.2	0.8	0.8	- 0.9	- 0.7	- 0.1	0.1	0.0	- 0.1	0.1
INCREASE IN UNEMPLOYMENT RATE (%)										
REFFUL82	0.1	0.2	0.2	0.0	- 0.1	- 0.1	0.0	0.0	0.0	0.3
NAIVE	0.1	0.2	0.2	0.0	- 0.2	- 0.1	0.0	0.0	0.1	0.3
GOVTSPEND	- 0.1	0.0	0.1	0.1	- 0.2	- 0.3	- 0.1	0.0	0.2	- 0.3
TAXCUT	0.0	0.1	0.2	0.0	- 0.2	- 0.2	- 0.1	0.0	0.1	0.1
PHASED	0.0	0.1	0.2	0.2	0.0	- 0.1	- 0.1	0.0	0.0	0.3

levels of GNP, prices, and employment. The estimated cumulative loss in real GNP increases to $30.8 billion (1972 dollars), and the cumulative effect on inflation is to add 0.7 percentage points, instead of 0.4 percentage points found in the REFFULL82 case. The cumulative effect on the unemployment rate is to add 0.3 percentage points to the REFFUL82 levels. However, employment levels in the REFFUL82 and REFCUR85 simulations are within 0.1 percent of each other by 1990.

3.4.2 GOVTSPEND Simulation

In the REFFUL82 simulation, the Federal deficit is improved in 1982, relatively unchanged between 1983-1985, higher in 1986-1988, and slightly worse in 1989 and 1990. Increases in tax revenues in 1982, caused by higher nominal incomes and profits, exceed comparable increases in Federal outlays. In 1985-1987, higher levels of real economic activity, and the associated effects on tax receipts and transfer payments, further lead to positive effects on the Federal deficit. To return the budget deficit to base case levels, therefore, increases in Federal spending or cuts in taxes would be required.

As indicated in Table 3-2, the effect of altering Federal spending levels is to substantially alter the real GNP changes. Real GNP losses are sharply curtailed in the first four years, and the change in real GNP in 1982 between the REFCUR85 and GOVTSPEND simulations is actually positive.[1] By 1986, the expansion forecast in the REFFUL82 simulation is increased substantially. Since government spending is a direct component of GNP, gains are to be expected. In addition, the spending "multiplier" on the economy (the feedback effects of an increase in spending on the rest of the economy) is in the range of one and a half to two times the change in spending. The cumulative change in real GNP between 1982-1990 is a $11.3 billion (1972 dollars) gain. This, however, also leads to increased inflation - the cumulative difference in the inflation rate is 1.1 percentage points, versus 0.8 in the REFFUL82 case.

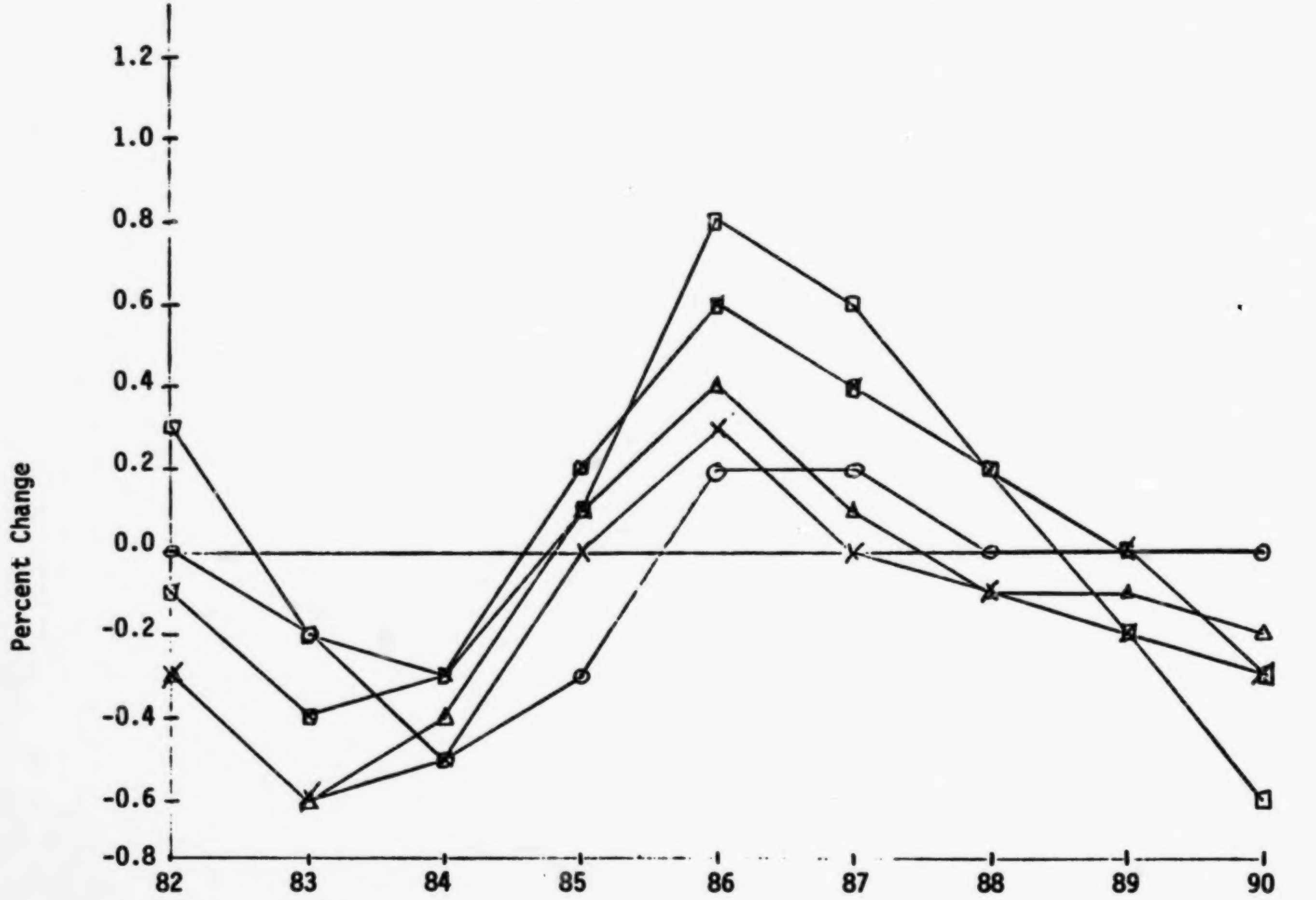
---

[1] The positive effect in 1982, and in subsequent years such as 1986, in part are due to the approach used. To bring the deficit into balance, real government spending was increased by the amount required. This, however, produces secondary effects - as the economy expands with the spending increase, additional tax receipts are collected. Thus, a change even larger than the initial difference in the budget deficit is required to bring the deficit back to REFCUR85 levels, producing significant effects on GNP.

FIGURE 3-4

Percent Change in Real GNP

Alternative Simulations versus REFCUR85



△ REFFUL82	-0.3	-0.6	-0.4	0.1	0.4	0.1	0.1	0.1	-0.2
× NAIVE	-0.3	-0.6	-0.5	0.0	0.3	0.0	-0.1	-0.2	-0.3
☐ GOVTSPEND	0.3	-0.2	-0.3	0.1	0.8	0.6	0.2	-0.2	-0.6
☒ TAXCUT	-0.1	-0.4	-0.5	0.2	0.6	0.4	0.2	0.0	-0.3
○ PHASED	0.0	-0.2	-0.5	-0.3	0.2	0.2	0.0	0.0	0.0

3.4.3 TAXCUT Case

Similarly, in the TAXCUT case, real GNP losses from accelerated decontrol are markedly changed from REFFUL82 levels. By recycling revenues back to consumers, real after-tax incomes are restored to base case levels or increased. This increase affects consumer spending, and indirectly impacts other categories of GNP. The cumulative gain in real GNP is $6.1 billion, or $25.5 billion more than in the REFFUL82 simulation. While the level of economic activity is up, prices, such as the GNP deflator, also increase. The cumulative effect on the GNP deflator inflation rate is to increase it by 1.1 percentage points.

3.4.4 PHASED Case

In the PHASED case, the overall impact on GNP and prices is less than in the REFFUL82 case; the loss in GNP is $9.2 billion less in the PHASED case and the cumulative impact on prices is 0.7 percentage points less. Employment is virtually the same as in the REFFUL82 case.

Aggregate prices indexes do not rise as much in the PHASED case primarily because of the speed at which natural gas prices rise. By more gradually introducing higher natural gas prices to consumers, their reaction is weaker; wage earners are less likely to demand increases in wages to compensate for the price rises, and producers will be less likely to pass on higher costs to consumers. However, the gradual rise in prices also postpones the economic recovery until 1986.

SUMMARY AND LIMITATIONS OF THE STUDY

The results from the DRI model analysis of accelerated decontrol, as well as the alternative simulations performed, suggest three principal conclusions:

- First, accelerated decontrol may lead to increased inflation in the short-term, given DOE projections on natural gas supply, demand, and prices. These effects, however, are adverse only for the first three years. By 1985, accelerated decontrol averts the potential effect of NGPA pricing provisions on inflation. Over the entire period, only minor changes in inflation are forecast.
- Second, the simulations show a definite pattern in the response of the economy to accelerated decontrol. In early years, decontrol leads to declines in real economic activity and employment. In subsequent years, this response is reversed.
- The ultimate impact of accelerated decontrol is indeterminate. Depending upon the assumptions used, cumulative losses or gains in real GNP, employment, etc. can be shown. The alternative fiscal policy simulations demonstrate that while accelerated decontrol will significantly affect the economy, its impacts are not dominant. Appropriate Federal policies, such as tax cuts, to restore real disposable incomes and profits lost through inflation, can totally ameliorate (and, in fact, more than offset) any adverse economic effects from accelerated decontrol of natural gas prices.

There are many shortcomings in the analysis which limit its usefulness. First and foremost, the impact estimates are highly sensitive to estimates of the effects of accelerated decontrol on natural gas prices, natural gas supply and demand, and oil imports. Changes in the estimated values would significantly affect the results.

Even if the estimate of the effects of natural gas pricing were completely accurate, this would not insure that the estimates from the DRI model would also be accurate. Factors which limit the model's usefulness include:

1) The model is, in essence, a short-term forecasting tool, primarily designed to analyze the behavior of the for one to three years. The fact that it is a quarterly model suggest that errors in the model's forecast will be compounded over time, leading to larger errors in subsequent years. Moreover, the orientation of the model, and particularly its theoretical structure, is not designed to forecast beyond the short-term. Thus, the results from the model's simulations for years such as 1990 should be heavily discounted.

2) The model is oriented towards explaining economic activity by focusing on the determinants of aggregated demand. When analyzing policies such as accelerated decontrol, effects from the supply-side of the economy are as important, if not more so, as demand effects. The adjustment made in the REFFULL82 simulation to account for benefits such as the reduction in real resource costs due to decontrol is an imperfect attempt to make the model respond to supply effects such as these.

3) The inflation effects forecast by the model may be overstated. The form of the equations used in the model to forecast prices uses fixed coefficients to explain how industrial and final prices respond to increased costs of inputs in the production process. To the extent that producers adjust inputs into production as relative input prices change, these cost-saving responses will not be captured.

4) Finally, the results from the model are highly sensitive to assumptions made in the analysis. Fiscal and monetary policy responses, effects of decontrol on trade, the effects of decontrol on new investment in natural gas exploration and extraction, and the direction of future oil prices are all examples of critical assumptions which contribute significantly to the forecast economic effects.

Given these limitations, the results should be viewed as illustrative, and not definitive, estimates of the ultimate impact of accelerated decontrol.

APPENDIX A

Analytical Approach Used to Represent Natural Gas Decontrol in the DRI·Model

This appendix provides details on the approach used to represent accelerated decontrol in the DRI Model. Inputs into the model are explained and explanations of the rationale for adjusting certain non-energy economic variables are provided.

All of the simulations were developed using the 1980C version of the DRI Short-Term Quarterly Model. The simulations were based upon a standard DRI simulation entitled "OPTIMLONG2006", a forecast of the U.S. economy to the year 2006 which, in the short and mid-term, is generally consistent with that of the President's Program for Economic Recovery.[1] Small changes were made to the OPTIMLONG2006 forecast to align certain non-natural gas variables, such as the price of crude oil and petroleum products, to forecasts prepared by DOE. These changes did not significantly affect the economic forecast.

Although OPTIMLONG2006 is a forecast which extends to the year 2006, the natural gas simulations were prepared only for the years 1982 through 1990. The year 1990 was chosen as the ending point for two reasons; a desire to conserve resources, and the understanding that the orientation of the model is towards the short-term.

In the following section, variable changes introduced to develop the REFCUR85 and REFFUL82 simulations are discussed. Following this, Section A.2 describes the techniques used to develop the alternative simulations.

A.1 Variable Changes for the REFCUR85 and REFFUL82 Simulations

1) Wellhead Price of Natural Gas (WPI053)

The DRI model does not have a specific variable for the wellhead price of natural gas. It does, however, contain the producer price index for gas fuels (WP1053), a weighted average of the prices of interstate,

---

[1] In prior stages of this research, simulations were also developed based upon DRI's TRENDLONG2006 forecast. Because the differences in economic impact estimates were not significant, and in order to conserve resources, only the OPTIMLONG2006 forecast was used in this anaysis.

APPENDIX A

intrastate, and imported natural gas, and the price of liquefied petroleum gases (propane, butane, and ethane), with an index base of 1967 = 1.00. In the construction of the index, the price of natural gas is measured at the wellhead. The "relative importance" of each of these fuels in the construction of the index is dertermined by the Bureau of Labor Statistics.[1]

To calculate the PPI for gas fuels in each of the cases, data from DOE on the wellhead and imported price of gas, along with the exogenously-determined price of LPG's, were used to construct the index. The index was determined by calculating the percentage change in the price of natural gas from 1980 levels and then multiplying it by the 1980 index level. The equation is:

$$\mathrm{WPI053} = \left[\left(.609 * \left(\frac{\mathrm{PWELL80*INFLATE}}{2.02}\right)\right) + \left(.075* \left(\frac{\mathrm{PIMP80*INFLATE}}{4.56}\right)\right) + \left(.316*\frac{\mathrm{PLPG}}{13.35}\right) \right] * 7.629$$

where:

.609 = Relative importance, inter/intrastate natural gas

PWELL80 = Average wellhead price of natural gas (1980$)

2.02 = 1980 price of gas (from DOE)

INFLATE = Rate of inflation from 1980 levels, based on the GNP deflator (1980 = 1.000)

.075 = Relative inportance, imported gas

PIMP80 = Price of imported natural gas (1980$)

4.56 = 1980 price of imported gas (from DOE)

.316 = Relative importance, LPG's

PLPG = Price of LPG's (nominal $)

13.35 = 1980 price of LPG's

7.529 = 1980 value of WPI053

Using this equation, quarterly values for WPI053 were calculated. Annual values are shown in Table A-1. In addition, the value of WPI053BASE, an exogenously specified value, was also set equal to the value of WPI053.[2]

---

[1] See Supplement to Producer Prices and Price Indexes Data for 1979, Bureau of Labor Statistics, U.S. Department of Labor, October, 1980.

[2] In the 1980C version of the model, the values of certain variables such as WPI053 are essentially exogenous. Changes in inflation rates from the base case, however, will move these prices indices. Unfortunately, the measure of inflation used is the producer price index, which is not consistent with deflation in the DOE estimates which use the GNP deflator. Therefore, the "simulation rule" used in the model was overridden by exogenizing both values of the variable.

APPENDIX A

A.2 Retail Price of Natural Gas (PCSHHOPG)

The DRI model does not contain an explicit variable denoting the price of natural gas at the retail level. It does have the variable (PCSHHOPG) which is the implicit price deflator - personal consumption expenditures (PCE) - natural gas. This time series is developed by BEA and used to deflate nominal values. PCE-natural gas was calculated based on DOE estimates of residential gas prices, using the change from 1980 levels and the 1980 index value:

$$\text{PCSHHOPG} = \left[\frac{\text{PRES80} * \text{INFLATEPC}}{4.04}\right] * 2.942$$

where: PRES80 = Residential price of natural gas (1980$)

INFLATEPC = Rate of inflation from 1980 levels based on the aggregate PCE deflator (1980 = 1.000)

4.04 = 1980 price of residential natural gas (from DOE)

2.942 = 1980 value of PCSHHOPG

Table A-1 shows the annual values of PCSHHOPG in each simulation.

A.3 Residential Consumption of Natural Gas (CSHHOPG72)

The variable (CSHHOPG72) in the DRI model represents real PCE of natural gas (1972 dollars). To calculate its values for the simulations, the ratio of consumption of natural gas in the relevant time period to 1980 levels is multiplied by the 1980 value of (CSHHOPG72):

$$\text{CSHHOPG72} = \left(\frac{\text{QRES}}{4.959}\right) * 6.4$$

where: QRES = Quantity consumed, residential sector (TCF)

4.959 = Quantity consumed, residential sector (TCF), in 1980

6.4 = 1980 value of CSHHOPG72

Table A-1 displays the calculated values in annual terms.

A.4 Price of Natural Gas to Electric Utilities (WPI054)

The DRI model does not contain an explicit variable for the price of natural gas to utilities. It does, however, contain a variable denoting the producer price index - electricity. In the model, the price index for electricity will change by the percentage changes of coal, gas, and oil prices from their original (base case) levels, weighted by these three fuels' relative shares in the production process. Exogenizing the value of both WPI053 and WPI053BASE (the exogenized value), this relationship will not adjust properly with natural gas price changes.[1]

To correct for this problem, the amount of adjustment that should take place, given that the price of gas to utilities changes, is calculated and added to the value of WPI054BASE (the exogenized value). First, the change in gas costs to utilities is calculated:

$$\Delta \mathrm{GASCOSTS} = (\Delta \mathrm{PGASEU80} * \mathrm{INFLATE})/1.021$$

where:
GASCOSTS = Change in gas costs, dollars per million BTU's
PGASEU80 = Change in the price of gas (1980$) per mcf
1.021 = Conversion factor to BTU terms

Next, the implication of a change in gas costs to the price per Kwh is calculated, assuming that the average efficiency of electricity production is 32.0% and given the share of gas to total fuels from DOE:

$$\Delta \mathrm{PKWH} = (\Delta \mathrm{GASCOSTS}/.32) * \mathrm{SHAREGAS} * .3412$$

where:
Δ PKWH = Change in the price per Kwh (cents/Kwh)
Δ GASCOSTS = Change in gas costs, dollars per million Btu's
.32 = Assumed efficiency of electricity generation
SHAREGAS = Proportion of gas to total fuel consumption by electric utilities.
.3412 = Conversion to Kwh from Btu's and conversion to cents.

Finally, the change in the exogenized index value can be calculated, based on the change in the price of electricity and the approximate average price of electricity in the base year (1967):

$$\mathrm{WPI054BASE} = \mathrm{WPI054BASE}^* + (\Delta \mathrm{PKWH}/1.70)$$

where:
WPI054BASE = PPI Electricity (exogenized value)
WPI054BASE* = PPI Electricity (exogenized value), prior to adjustment.
1.70 = Approximate price of electricity in 1967

Table A-1 shows the calculated values for the two cases.

---

[1] Recall that both WPI053BASE and WPI053 were exogenized to prevent the model from deflating using the producer price index. The ratio of change between these two values will then be zero in the WPI054 equation.

APPENDIX A

A.5 Production of Natural Gas (JQIND13)

The variable (JQIND13) is the Federal Reserve Board's industrial production index - oil and gas extraction. It is an index of output with a base year of 1967.

Changes in natural gas production were reflected in the model by "add-factoring", or adjusting, the variable (&JQIND13). Given that 1967 gas production was about 17.39 TCF and that approximately 21.8% of the index is gas production (with the remainder being oil), the equation used is:

$$\&JQIND13 = (\Delta PROD/17.39) * .218$$

where: &JQIND13 = Addfactor, industrial production of oil and gas

ΔPROD = Change in production of gas (TCF)

17.39 = Domestic production of gas in 1967 (TCF)

.218 = Approximate contribution of gas to the total index

This adjustment was only made in the REFFUL82 case, and was based on the change in production between the two cases. The annual values are shown in Table A-1.

A.6 Price of Natural Gas Imports (JMEND10)

The variable (JMEND10) is the unit value index of fuel imports, with an index base of 1967 = 1.00. It includes both the price of oil and gas imports.

The value of the index may change for one of two reasons. First, changes in the price of either oil or gas will obviously affect the value of the variable. And second, if the relative shares of either oil or gas changes, the index will also change.

The computation of the index value of (JMEND10) considered both of these possibilities. The index is calculated by weighting the change in both oil and gas prices from their 1967 price levels by their relative share in total fuel imports using the equation:

$$JMEND10 = SHAREGAS * \left[\frac{PIMP80*INFLATE}{.258}\right] + (1.0 - SHAREGAS) * \left[\frac{PCOFBASE}{2.66}\right]$$

where: JMEND10 = Unit Value Index, oil and gas imports (1967 = 1.00)

SHAREGAS = Share of gas to total imports

PIMP80 = Price of imported natural gas (1980$)

INFLATE = Rate of inflation from 1980 levels, based on implicit GNP deflator (1980 - 1.000)

.258 = 1967 price of imported gas ($/mcf)

PCOFBASE = Price of imported crude oil
2.66 = 1967 price of oil, including crude, residual, and products, with compositional changes since 1967 considered.

As seen in Table A-1, neither the value of (JMEND10) or its exogenized value (JMEND10BASE) changes considerably.

A.7 Oil and Gas Imports (MEND1067)

Changes in oil consumption in the industrial sector, due to substitution from oil to natural gas, are unlikely to be captured with the equation used to forecast fuel imports (MEND1067) in the model. These substitution effects are reflected in the model by adjusting the "add-factor" on fuel imports (&MEND1067) by the change as forecast by DRI. The 1967 price term used to calculate the addfactor assumed that the weighted average price of crude oil and petroleum products sold for $2.66 per barrel. (Note that this is consistent with the price term used to compute the unit value index, fuel imports (JMEND10). Annual values of the addfactor are shown in Table A-1.

A.8 State and Local Severence Taxes (&TXGSL)

Changes in natural gas prices will lead to increased revenues to gas producers. A part of this increased revenue will be paid to state and local governments through severence (lease and royalty) taxes. DOE analysis provided estimates of the level of taxes to be paid, and this amount was reflected in the model by adjusting the "add-factor" (&TXGSL) by the appropriate amount (see Table A-1).

A.9 Foreign Trade Variables (&WPIW, EXCH)

In the course of preparing simulations of the impacts of decontrol, adjustments were made to the values of two trade variables in the model. First, the model does not adequately forecast the value of the wholesale price index for U.S. trading partners (WPIW). Instead, an exogenous value (WIPWBASE) is specified in the model. The equation for (WPIW) permits the forecast value to differ from the exogenized value (WIPWBASE) based on the rate of change in the U.S. producer price index (PPI). As specified, approximately 100% of the change in the U.S. PPI will be reflected in the value of (WPIW); a lag is specified such that the full amount of the change will be shown by the third year.

Since the natural gas decontrol is essentially a domestic policy, it should not have nearly as strong an affect on foreign prices as it does on U.S. prices. Some effect, however, will occur as U.S. price inflation is exported through trade with other countries. For the simulation, it was assumed that approximately 50% of the change in U.S. prices will be transmitted to foreign prices. For example, if U.S. prices (as measured by the PPI) rise by 10%, the assumption is that foreign prices will rise by only 5.0%. An adjustment was made to the "add-factor" (&WPIW) (shown in Table A-1). With this adjustment, relative price differentials between U.S. and foreign goods are consistent with changes in U.S. price inflation.

APPENDIX A

Similarly, the DRI model does not adequately forecast the value of the exchange rate (EXCH). Since the model does not cosider the balance on either the capital or the intervention accounts, a rigorous specification of this variable is not possible. The "simulation rule" used in the model to adjust the exchange rate tended to produce anomalous results. Therefore, the value of (EXCH) was exogenized in the simulations at base case levels. In doing so, the affect of relative price changes appear to be accurate. At the same time, differences in the nominal trade balance (a somewhat useful variable for gauging the plausibility of the exchange rate assumption) are small between cases.

A.10 Reflecting Real Resource Effects (GNP72FE, UCAPFRBM)

By far the most difficult adjustment made in the simulations is the adjustment made to account for real-resource effects associated with decontrol. No variable in the DRI model explicitly captures the effects of this gain. Any attempt to simulate the effects of a real resource gain in the DRI model will be inperfect at best.

Two alternative techniques were considered for reflecting real resource gains in the simulations. In the first, adjustment to the values of specific producer price indexes, such as the PPI-metals, could be made. These adjustments would show the change in costs (and hence prices) due to the increase in efficiency of allocation of energy resources. Although conceptually appealing, identifying the specific appropriate indexes, as well as determining the size of the changes, is difficult and likely to be inaccurate.

Alternatively, real resource effects can be shown by adjusting potential GNP - the measure of the amount of goods and services produced if labor is fully employed - by the amount of the real resource gain. In the DRI model, potential GNP (GNP72FE) is calculated as a function of the capital stock, labor resources, and energy. If the amount of real energy resources available changes with decontrol, potential should rise.[1]

Estimates of real resource gains were provided by DOE. These were shown in the model by "add-factoring" the value of potential GNP (&GNP72FERAW), (see Table A-1 for annual values). In addition, one other variable required adjustment. The rate of capacity utilization (UCAPFRBM) should change as the gap between realized and potential GNP changes. The percentage change in potential GNP between the simulations was used to calculate the appropriate adjustment for capacity utilization.

---

[1] In the specification of potential GNP in the model, DRI uses the total demand for fuels as a proxy for real energy resources. In the simulations, demand for fuels falls with changes in gas prices, leading to a decline in potential GNP. The adjustment made, then, in part simply corrects for the model's incorrect adjustment.

TABLE A-1

VARIABLE CHANGES IN THE REFFUL82 SIMULATION

A - Value in REFFUL82 Simulation
B - Value in REFCUR85 Simulation
D - Difference
% - Percentage Difference from REFCUR85 Simulation

--- PCSHHOPG **Implicit Price Deflator - Consumption of Natural Gas**

	82	83	84	85	86	87	88	89	90
A	5.290	5.727	6.226	6.777	7.201	7.652	8.202	8.843	9.507
B	3.717	4.218	4.709	6.749	7.127	7.453	8.051	8.661	9.317
D	1.573	1.509	1.517	0.028	0.075	0.200	0.151	0.182	0.190
%	42.3	35.8	32.2	0.4	1.0	2.7	1.9	2.1	2.0

--- CSHHOPG72 **Personal Consumption Expenditures - Natural Gas - 1972 Dollars**

	82	83	84	85	86	87	88	89	90
A	5.9	6.0	6.0	6.0	6.3	6.4	6.4	6.3	6.3
B	6.4	6.4	6.5	6.4	6.4	6.4	6.4	6.4	6.4
D	-0.5	-0.5	-0.5	-0.3	0.0	0.0	0.0	0.0	0.0
%	-8.5	-7.4	-7.1	-5.2	-0.2	-0.6	-0.5	-0.5	-0.5

--- WPI053 **Producer Price Index - Gas Fuels**

	82	83	84	85	86	87	88	89	90
A	16.775	18.861	21.184	23.655	25.653	27.792	30.428	33.319	36.385
B	11.554	13.484	15.537	23.385	25.247	27.267	30.009	32.859	35.929
D	5.221	5.377	5.647	0.270	0.406	0.525	0.419	0.460	0.456
%	45.2	39.9	36.3	1.2	1.6	1.9	1.4	1.4	1.3

--- WPI054 **Producer Price Index - Electric Power**

	82	83	84	85	86	87	88	89	90
A	4.459	4.941	5.489	5.796	6.087	6.493	6.885	7.268	7.659
B	4.202	4.597	5.126	5.717	6.090	6.483	6.870	7.251	7.642
D	0.257	0.344	0.362	0.079	-0.003	0.010	0.014	0.018	0.018
%	6.1	7.5	7.1	1.4	0.0	0.2	0.2	0.2	0.2

---&JQIND13 **Add Factor - Oil and Gas Extraction**

	82	83	84	85	86	87	88	89	90
A	0.004	0.007	0.009	0.002	-0.002	-0.006	-0.004	-0.006	-0.006
B	•NA	•NA	•NA	•NA	•NA	•NA	•NA	•NA	•NA
D	NA	NA	NA	NA	NA	NA	NA	NA	NA
%	NA	NA	NA	NA	NA	NA	NA	NA	NA

--- JMEND10 **Unit Value Index of U.S. Imports - Fuels and Lubricants**

	82	83	84	85	86	87	88	89	90
A	14.927	16.567	18.163	19.809	21.257	22.842	24.706	26.661	28.750
B	15.009	16.692	18.292	20.790	22.110	23.349	25.179	27.101	29.169
D	-0.082	-0.125	-0.129	-0.980	-0.853	-0.508	-0.474	-0.440	-0.419
%	-0.5	-0.7	-0.7	-4.7	-3.9	-2.2	-1.9	-1.6	-1.4

---&MEND1067 **Add Factor - U.S. Imports by End-Use Categories - Fuels and Lubricants - 67$**

	82	83	84	85	86	87	88	89	90
A	2.23	2.77	3.36	3.69	4.68	3.88	3.31	2.82	2.29
B	2.62	3.23	3.87	4.44	4.23	3.73	3.20	2.66	2.11
D	-0.39	-0.46	-0.52	-0.75	0.46	0.15	0.12	0.16	0.18
%	-14.9	-14.3	-13.3	-16.8	10.8	4.1	3.7	6.1	8.6

---&TXGSL **Add Factor - State and Local Government Receipts**

	82	83	84	85	86	87	88	89	90
A	4.7	3.8	3.3	0.5	-0.3	-1.2	-2.4	-3.7	-5.2
B	2.2	1.3	0.7	0.1	-0.7	-1.6	-2.7	-4.0	-5.5
D	2.5	2.5	2.6	0.4	0.4	0.4	0.3	0.3	0.3
%	116.2	193.4	352.2	355.7	-60.2	-23.2	-10.9	-7.8	-5.6

TABLE A-1 Con't

	82	83	84	85	86	87	88	89	90
---&WPIW	Add factor - Composite Index of WPI's of Major U.S. Trading Partners								
A	0.000	-0.066	-0.080	-0.093	-0.018	-0.015	-0.011	-0.008	-0.005
B	*NA	*NA	*NA	*NA	*NA	*NA	*NA	*NA	*NA
D	NA	NA	NA	NA	NA	NA	NA	NA	NA
%	NA	NA	NA	NA	NA	NA	NA	NA	NA
---&UCAPFRBM	Add factor - Capacity Utilization - Manufacturing - Total								
A	0.032	0.016	-0.001	-0.018	-0.035	-0.047	-0.046	-0.039	-0.029
B	0.034	0.018	0.001	-0.018	-0.035	-0.047	-0.046	-0.039	-0.029
D	-0.002	-0.001	-0.001	0.000	0.000	0.000	0.000	0.000	0.000
%	-4.5	-8.1	-271.8	1.2	0.5	0.1	0.1	0.1	0.1
---&GNP72FERAW	Add factor - Full Employment Level of Real Gross National Product								
A	11.1	15.9	19.1	18.8	20.8	22.7	24.7	26.8	28.8
B	8.1	13.1	16.3	18.4	20.5	22.5	24.6	26.7	28.8
D	3.0	2.8	2.8	0.4	0.4	0.2	0.1	0.1	0.1
%	36.4	21.2	17.0	2.4	1.9	0.7	0.4	0.3	0.2

MICROFILMED FROM BEST
AVAILABLE COPY

APPENDIX A

A.11 Adjustments Made in the Alternative Simulations

To develop the alternative simulations, several variables were changed. In the NAIVE case, all adjustments made to reflect real resource gains in the REFFUL82 case were omitted. This involved restoring the values of &GNP72FERAW and &UCAPFRBM, to REFCUR85 simulation levels. It was also assumed that output per manhour would not be affected in the first year of the simulation. A small adjustment to this variable (&JQ%MHNF) was necessary to keep productivity at its base level in 1982.

In the two alternative fiscal policy simulations, adjustments were made to either government expenditures or personal income taxes to return the nominal Federal deficit/surplus (DEFGF) to REFCUR85 levels. Because of the fiscal multipliers within the model, the original difference in the budget balance is not the size of the change required. For example, increased expenditures stimulate economic growth, and therefore increase tax revenues. Therfore, an increase in expenditures larger than the initial budget difference is required.

To derive the appropriate adjustments, the "search" routine available in the DRI model program was used. This technique insures that the projected budget balance, after the model is solved, will be within 0.5% of the targetted level. In the GOVTSPEND case, the value of real non-defense expenditures (GF072EXO) was adjusted, while in the TAXCUT case the rate of taxation of personal income (&RTPGF) was altered. The model-derived adjustments required to return the deficit to REFCUR85 levels produced the following changes in these variables.

GOVTSPEND Case	82	83	84	85	86
GF072EXO	6.4	2.2	1.0	-0.1	4.4
TAXCUT Case					
&RTPGF	-.0043	-.0011	-.0008	-.0004	-.0031

	87	88	89	90
GOVTSPEND Case	4.8	2.5	-0.5	-3.2
TAXCUT Case	-.0030	-.0016	-.0001	.0011

A positive number in the change to (GF072EXO) in the GOVTSPEND simulation denotes that real spending was increased; a negative number in the change to (&RTPGF) in the TAXCUT case means that personal taxes were cut.

The variables changed in the PHASED case were the same as those adjusted in the REFFUL82 case. The equations used to determine the magnitude of the changes were also the same. The variable changes are displayed in Table A-2.

TABLE A-2

VARIABLE CHANGES IN THE PHASED DECONTROL CASE

A - Value In PHASED Simulation
B - Value in REFCUR85
D - Difference
% - Percentage Difference from REFCUR85 Simulation

--- PCSHHOPG Implicit Price Deflator - Consumption of Natural Gas

	82	83	84	85	86	87	88	89	90
A	3.952	5.169	6.267	6.818	7.233	7.663	8.214	8.831	9.494
B	3.717	4.218	4.709	6.749	7.127	7.453	8.051	8.661	9.317
D	0.235	0.951	1.557	0.069	0.107	0.211	0.163	0.170	0.177
%	6.3	22.6	33.1	1.0	1.5	2.8	2.0	2.0	1.9

--- CSHHOPG72 Personal Consumption Expenditures - Natural Gas - 1972 dollars

	82	83	84	85	86	87	88	89	90
A	6.3	6.1	6.0	6.3	6.3	6.4	6.4	6.3	6.3
B	6.4	6.4	6.5	6.4	6.4	6.4	6.4	6.4	6.4
D	-0.1	-0.3	-0.4	0.0	0.0	0.0	0.0	0.0	0.0
%	-1.5	-5.0	-7.0	-0.2	-0.3	-0.7	-0.5	-0.5	-0.5

--- WPI053 Producer Price Index - Gas Fuels

	82	83	84	85	86	87	88	89	90
A	12.328	16.724	21.053	23.793	25.727	27.831	30.428	33.319	36.385
B	11.554	13.484	15.537	23.385	25.247	27.267	30.009	32.859	35.929
D	0.774	3.240	5.516	0.408	0.480	0.564	0.419	0.460	0.456
%	6.7	24.0	35.5	1.7	1.9	2.1	1.4	1.4	1.3

--- WPI054 Producer Price Index - Electric Power

	82	83	84	85	86	87	88	89	90
A	4.237	4.754	5.437	5.796	6.082	6.477	6.869	7.253	7.645
B	4.202	4.597	5.126	5.717	6.090	6.483	6.870	7.251	7.642
D	0.035	0.157	0.310	0.079	-0.008	-0.006	-0.001	0.003	0.004
%	0.8	3.4	6.1	1.4	-0.1	-0.1	0.0	0.0	0.0

---&JOIND13 Add Factor - Oil and Gas Extraction

	82	83	84	85	86	87	88	89	90
A	0.001	0.006	0.008	-0.001	-0.003	-0.006	-0.005	-0.006	-0.006
B	◆NA	◆NA	◆NA	◆NA	◆NA	◆NA	◆NA	◆NA	◆NA
D	NA	NA	NA	NA	NA	NA	NA	NA	NA
%	NA	NA	NA	NA	NA	NA	NA	NA	NA

--- JMEND10 Unit Value Index of U.S. Imports - Fuels and Lubricants

	82	83	84	85	86	87	88	89	90
A	15.009	16.692	18.290	19.823	21.272	22.852	24.706	26.661	28.750
B	15.009	16.692	18.292	20.790	22.110	23.349	25.179	27.101	29.169
D	0.000	0.000	-0.002	-0.967	-0.838	-0.497	-0.474	-0.440	-0.419
%	0.0	0.0	0.0	-4.6	-3.8	-2.1	-1.9	-1.6	-1.4

---&MEND1067 Add Factor - U.S. Imports by End-Use Categories - Fuels and Lubricants - 67$

	82	83	84	85	86	87	88	89	90
A	2.53	2.87	3.38	4.44	4.32	3.90	3.32	2.82	2.28
B	2.62	3.23	3.87	4.44	4.23	3.73	3.20	2.66	2.11
D	-0.09	-0.35	-0.49	0.00	0.09	0.17	0.12	0.15	0.17
%	-3.5	-11.0	-12.7	0.1	2.1	4.7	3.9	5.8	7.8

---&TXGSL Add Factor - State and Local Government Receipts

	82	83	84	85	86	87	88	89	90
A	2.5	2.7	3.2	0.5	-0.2	-1.2	-2.4	-3.7	-5.2
B	2.2	1.3	0.7	0.1	-0.7	-1.6	-2.7	-4.0	-5.5
D	0.4	1.4	2.4	0.4	0.4	0.4	0.3	0.3	0.3
%	16.3	111.5	336.0	407.6	-67.0	-25.2	-11.6	-8.0	-5.5

TABLE A-2 Con't

	82	83	84	85	86	87	88	89	90
---&WPIW	**Add Factor - Composite Index of WPI's of Major U.S. Trading Partners**								
A	0.000	-0.033	-0.053	-0.093	-0.018	-0.015	-0.011	-0.008	-0.005
B	◆NA	◆NA	◆NA	◆NA	◆NA	◆NA	◆NA	◆NA	◆NA
D	NA	NA	NA	NA	NA	NA	NA	NA	NA
%	NA	NA	NA	NA	NA	NA	NA	NA	NA
---&UCAPFRBM	**Add Factor - Capacity Utilization - Manufacturing - Total**								
A	0.034	0.017	-0.001	-0.018	-0.036	-0.047	-0.046	-0.039	-0.029
B	0.034	0.018	0.001	-0.018	-0.035	-0.047	-0.046	-0.039	-0.029
D	0.000	-0.001	-0.002	0.000	0.000	0.000	0.000	0.000	0.000
%	-0.8	-5.5	-335.1	1.8	1.2	0.3	0.2	0.2	0.2
---&GNP72FERAW	**Add Factor - Full Employment Level of Real Gross National Product**								
A	8.6	15.0	19.7	19.1	21.4	22.8	24.8	26.9	28.9
B	8.1	13.1	16.3	18.4	20.5	22.5	24.6	26.7	28.8
D	0.5	1.9	3.4	0.7	1.0	0.3	0.2	0.2	0.1
%	6.3	14.4	21.1	3.7	4.7	1.4	0.7	0.7	0.5

ATTACHMENT III

THE MACROECONOMIC EFFECTS OF NATURAL GAS PRICE DECONTROL: SIMULATION RESULTS FROM THE WHARTON ANNUAL AND INDUSTRY FORECASTING MODEL

Prepared by

ICF, Incorporated

Washington, D.C. 20006
Under Contract No. DE-AC01-81PE-70274

EXECUTIVE SUMMARY

This attachment reports estimates of the macroeconomic effects of full and immediate decontrol of natural gas prices in January 1982 relative to the effects of partial decontrol in 1985 under the provisions of the Natural Gas Policy Act (NGPA), which will occur if current policy is not changed. The estimates were developed by simulating the behavior of the economy under the two gas decontrol alternatives using the Wharton Annual and Industry Forecasting Model.

Full decontrol in 1982 raises all natural gas prices in 1982-1984 above the levels that would have occurred under current policy. Average wellhead, residential, and commercial prices for the accelerated decontrol case remain above current policy levels for 1985-1990, but industrial and electric utility prices drop below current policy levels for those years.

The effects of accelerated decontrol relative to current policy on real GNP, inflation and unemployment are shown in Table S-1. Gas price increases reduce real income, consumption and output for the first three years after decontrol. GNP is higher in 1985 in the accelerated decontrol case, because NGPA decontrol occurs in that year in the base case. In most years after 1984, GNP will be higher with accelerated decontrol relative to current policy. Cumulative GNP losses for 1982-1990 are estimated to be $13.5 billion 1972 dollars.

The rate of inflation is increased by 2.0 to 2.5 percentage points during the first year of decontrol, whether it is 1982 or 1985. Full decontrol in 1982 adds about 2.5 percentage points to the inflation rate that year. Partial decontrol in 1985 adds about 2.0 percentage points to inflation in that year. The price level, as measured by the GNP deflator, is higher with accelerated decontrol in the entire 1982-1990 period, but after the 1982 spurt the rate of inflation slows and is lower in the accelerated decontrol case for 1985-1989 than in the current policy case. There is no difference in the rate of inflation between the two decontrol cases by the end of the decade, and the price level ends up only 0.1% higher in the accelerated full decontrol case.

Output losses can be completely offset by changes in government spending or tax policy. If the increased taxes that occur with accelerated decontrol are rebated to consumers via a personal tax cut, to keep the federal budget balance unchanged, GNP losses in all years but 1982 are avoided. If increases in defense or non-defense spending are used to keep the government budget balance unchanged, instead of a tax cut, GNP losses are completely avoided. In both simulations of offsetting fiscal policy changes inflation changes very little. Output increases lead to productivity gains which, by the end of the decade, leave the level of inflation slightly lower than in the standard decontrol case.

TABLE S-1

IMPACT OF ACCELERATED DECONTROL OF NATURAL GAS ON KEY ECONOMIC VARIABLES

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1982-1990 Cumulative	1982-1990 Average
Real GNP (Billions of 1972 Dollars)											
Base Case (REFCUR)	1556.0	1614.9	1685.4	1728.3	1788.1	1837.4	1895.4	1956.8	2025.0		
Change from Base Case Due to:											
Decontrol (REFFUL)	-6.6	-5.7	-3.3	6.9	-4.5	1.8	2.4	.1	-4.6	-13.5	-1.5
% Difference	-.4	-.4	-.2	.4	-.3	.1	.1	.0	-.2		
Decontrol Plus Personal Tax Cut (REFFULPT)	-.6	1.0	5.8	14.2	.3	7.4	10.3	8.2	2.2	48.8	5.4
% Difference	-.0	.2	.3	.8	.0	.4	.5	.4	.1		
Decontrol Plus Increased Government Spending (REFFULGOV)	7.3	5.9	10.5	14.7	.8	11.0	15.7	11.4	3.6	80.9	9.0
% Difference	.5	.4	.6	.8	.0	.6	.8	.6	.2		
Inflation: Rate of Change of Implicit GNP Price Deflator											
Base Case (REFCUR)	8.2	7.7	7.9	8.6	7.5	7.1	6.9	7.0	6.9		
Change from Base Case Due to:											
Decontrol (REFFUL)	2.5	.4	.2	-2.0	-.5	-.3	-.0	-.2	.0	0.1[a]	.0
% Difference	30.9	4.8	3.0	-20.6	-6.8	-4.6	-.5	2.9	.7		
Decontrol Plus Personal Tax Cut (REFFULPT)	2.5	.4	.3	-1.9	-.5	-.3	-.1	-.2	.0	0.0[a]	.0
% Difference	30.6	4.8	3.4	-19.8	-6.7	-4.7	-1.4	-3.5	.7		
Decontrol Plus Increased Government Spending (REFFULGOV)	2.6	.3	.3	-1.9	-.5	-.3	-.1	-.2	.1	0.0[a]	.0
% Difference	31.2	4.5	3.4	-19.7	-7.4	4.9	-1.5	-3.3	.9		
Unemployment Rate											
Base Case (REFCUR)	7.6	7.3	6.3	6.5	5.8	5.3	5.0	4.9	4.3		
Change from Base Case Due to:											
Decontrol (REFFUL)	.2	.1	.0	-.3	.0	-.1	-.1	-.1	.1		.0
% Difference	2.8	1.5	.5	-4.8	.4	-1.2	-2.5	-1.8	2.0		
Decontrol Plus Personal Tax Cut (REFFULPT)	.0	-.2	-.4	-.7	-.3	-.4	-.5	-.5	-.3		-.4
% Difference	.3	-2.4	-5.8	-11.0	-5.2	-7.1	-9.7	-9.6	-6.0		
Decontrol Plus Increased Government Spending (REFFULGOV)	-.4	-.5	-.7	-.8	-.3	-.5	-.7	-.6	-.3		-.5
% Difference	-4.9	-6.7	-10.7	-12.2	-5.4	-10.0	-14.6	-12.9	-7.8		

---

a/ Change in the price index level by end of period.

THE MACROECONOMIC EFFECTS OF NATURAL GAS PRICE DECONTROL: SIMULATION RESULTS FROM THE WHARTON ANNUAL AND INDUSTRY FORECASTING MODEL

The Natural Gas Policy Act of 1978 (NGPA) provides for decontrol of the wellhead price of most natural gas in 1985. An alternative to this policy is accelerated full decontrol of all wellhead prices. This report describes the effects on the U.S. economy of full natural gas decontrol in 1982 and the elimination of the Powerplant and Industrial Fuel Use Act (FUA) and compares them with the economic effects of partial decontrol in 1985 under the NGPA. The investigation was done by simulating the behavior of the economy under both policies using the Wharton Annual and Industry Forecasting Model (WAIFM) together with the DOE Gas Market Evaluation System (GMES).

This report is divided into six parts: (1) brief description of the assumptions used in the DOE Gas Market Evaluation System two market model to simulate the alternative decontrol scenarios; (2) description of the Wharton Annual and Industry Forecasting Model and the differences between WAIFM and GMES; (3) presentation of the assumptions used to simulate the economic effects of alternative decontrol scenarios using WAIFM; (4) presentation and discussion of the results of the simulations; (5) discussion of simulations of two alternative fiscal policy responses that may accompany accelerated decontrol--a personal tax cut and an increase in government defense and non- defense spending; (6) discussion of potential limitations of WAIFM and how they may affect the results.

1. THE DOE NATURAL GAS MARKET MODEL

The input data for the macroeconomic simulations were generated by simulating the behavior of the U.S. natural gas market under the alternative decontrol scenarios using the DOE Gas Market Evaluation System.[1] The GMES model depicts the structure of the natural gas market. It produces estimates of natural gas production and the equilibrium price and quantity consumed by each of four major users: industrial, commercial, electric utility, and residential. GMES also produces estimates of oil consumed by users who can burn either oil or gas. The economic benefits of gas consumption are estimated using the concepts of consumer and producer surplus. All estimates are for both interstate and intrastate gas markets.

---

[1] The DOE Gas Market Evaluation System (GMES) was developed for the DOE Office of Policy, Planning and Analysis by ICF Incorporated. The gas price and consumption estimates used for this analysis were derived from the "two market model" component of the GMES. This model is described in detail in A Study of Alternatives to the Natural Gas Policy Act of 1978, Appendix A, "Two Market Analysis of Natural Gas Decontrol," U.S. Department of Energy, Office of Policy, Planning and Analysis, October 30, 1981.

The GMES model has been constructed to simulate a wide variety of natural gas policy options. This report deals with the macroeconomic effects of two decontrol policy options:

1) REFCUR85 - decontrol of most natural gas in 1985 as provided by the Natural Gas Policy Act of 1978, with end-use restrictions on the use of natural gas by industrial and new electric utilities in place as legislated;

2) REFFUL82 - decontrol of all natural gas in 1982 and elimination of end-use restrictions.

Data assumptions common to both policy options are listed in Table 1. The GMES takes as given a macroeconomic forecast and produces estimates of the behavior of the natural gas market under different policy scenarios. Macroeconomic effects are not simulated by the GMES model, so an additional model is required to estimate these effects.

2. THE WHARTON ANNUAL AND INDUSTRY FORECASTING MODEL

The Wharton Annual and Industry Forecasting Model (WAIFM) is a large-scale econometric model of the U.S. economy that was developed in the 1970's at Wharton Econometric Forecasting Associates. WAIFM is unique in that it is the only major macroeconomic model that uses annual data and includes an input-output table embedded within its structure. WAIFM was designed to forecast the behavior of the economy over a mid- to long-term period--about ten years into the future.

Determinants of aggregate supply primarily determine the level of output in the long run, whereas aggregate demand primarily determines the level of output in the short run. WAIFM attempts to depict both aspects. The model includes an income-expenditures representation of the determinants of aggregate demand and spending, along with an embedded interindustry structure with flexible coefficients and a neoclassical production function representation of the determinants of aggregate supply, industrial output, and the supply and demand for factor inputs. In the short run (1982-1984), the determinants of aggregate demand, such as income and prices, are of major importance. In the long run, the determinants of supply become more important. Over the nine year period of the simulations reported here, the model depicts both the cyclical behavior of the economy and its long term growth.

TABLE 1

Supply	
Conventional Gas Geology	USGS Median (updated)
Unconventional Supply	Medium
OCS Leasing Rate	U.S. BLM Plan
Import Quantity	Limited LNG, Ample Mexican/Canadian
Import Price (Canada and Mexico)	Initially 1980 price plus world oil price increases. After decontrol, at U.S. decontrolled price.
Alaskan Gas	Deliveries starting in November, 1986. Annual Quantity = 764 BCF/year
Transmission/Distribution Costs	1980 fixed cost and sectoral allocations of fixed cost
Utility Ratemaking	Average cost pricing at wholesale and retail
Demand	
Electric Utility	Moderate coal penetration
Industrial Coal Conversion	Medium
World Oil Price (1980 $/bbl)	1980 1985 1990 34.00 35.76 41.46
Economic Activity	DRI Trendlong real GNP growth rate: 1980 1985 1990 3.4% 4.1% 4.2%
Residential/Commercial Elasticity	-.25/-.21

NOTE: These assumptions are described in detail in A Study of Alternatives to the Natural Gas Policy Act of 1978, Appendix A, "Two Market Analysis of Natural Gas Decontrol," U.S. Department of Energy, Office of Policy, Planning and Analysis, October 30, 1981.

WAIFM is organized in eight main sectors: final demand, input-output, labor requirements, wage, industry prices, final demand prices, other income, and monetary. Most variables such as wages and prices are disaggregated into 56 industrial sectors. WAIFM is fully simultaneous and is solved with a procedure that insures consistency.[1]

The model's highly disaggregated structure makes it useful for energy policy simulations. By altering appropriate variables, WAIFM can be used to simulate the effects of natural gas price decontrol. The results of the simulations provide estimates of the effects of decontrol and illustrate how gas price changes have different effects in different parts of the economy.

WAIFM is one of several analytical tools that can be used to estimate the effects of decontrol. Other models provide different estimates. Consequently, the results presented in this paper should be used with care. These results indicate the potential direction of effects of decontrol on the aggregate economy as well as on individual sectors. They can be used along with the results from other models to estimate quantitatively the range of possible effects of decontrol. By considering the probable effects of natural gas decontrol conceptually and reviewing the estimates provided by several quantitative models, policymakers can develop an informed opinion of the likely direction and potential magnitude of those effects, of the degree of uncertainty characterizing the estimates, and of the sensitivity of the potential effects to other events and policies.

The next section of this paper presents a brief description of the methodology used to simulate the effects of natural gas decontrol using WAIFM. Most of the methodology is straightforward. The analytical approach was the following. The DOE Gas Market Evaluation System was used to estimate the effects on the natural gas market of continuation of current policy (NGPA) and of full and immediate decontrol in January 1982. Because WAIFM has a detailed representation of energy variables, it includes several explicit natural gas variables that correspond to GMES variables. Where both models independently provide estimates for the same variable, WAIFM was adjusted to use the GMES estimates. WAIFM was adjusted to reflect the GMES estimates of domestic natural gas supply, imports, prices, and demand by various users. All the changes that were made to WAIFM are described in detail in the Annex to this paper.

---

[1] For a more detailed discussion of the Wharton Annual Model, see "Preliminary Analysis of Natural Gas: The Structure and Behavior of the DRI and Wharton Models" report prepared for the Office of Deregulation, U.S. Department of Energy, April 1981 by ICF, Incorporated.

3. ASSUMPTIONS USED TO SIMULATE THE ECONOMIC EFFECTS OF THE NGPA AND ACCELERATED DECONTROL SCENARIOS

A. Current Policy Case--REFCUR85

The alternative decontrol simulations were developed using the current WAIFM forecast or "control solution", called CNTL1081. That forecast was developed initially by analysts at Wharton Econometric Forecasting Associates (WEFA) and incorporates their judgement concerning the future path of government expenditures, monetary policy, and other variables exogenous to the model. The WEFA forecast was then altered considerably to develop the current policy reference case simulation, REFCUR85.

Values of the following WAIFM variables were changed to match GMES REFCUR85 values:

1. Average wellhead price of natural gas
2. Gross output price of natural gas utilities
3. Residential price of natural gas
4. Import price of natural gas
5. Residential consumption of natural gas
6. Electric utility use of natural gas
7. Domestic production of natural gas
8. Imports of natural gas
9. Crude oil and refined product prices.

The values for all of the variables that were changed, for each of the simulations, for all of the years simulated are listed in the Annex.

Although both REFCUR85 and WEFA's CNTL1081 are intended to represent current policy, substantial changes were made to the CNTL1081 simulation, because the WAIFM estimates of the effects of current policy on natural gas variables differ significantly from the GMES estimates. CNTL1081 values are listed along with the GMES values in the Annex. The most significant differences occur in 1985, when WAIFM estimates of natural gas prices are significantly lower than GMES estimates. The lower WAIFM prices lead to much higher levels of residential gas consumption than estimated by GMES.

B. Full Accelerated Decontrol Case - REFFUL82

The simulation of full accelerated decontrol in 1982, REFFUL82, was developed in a manner similar to that used to develop the current policy case. Values of the nine sets of WAIFM variables listed above were changed to reflect the GMES estimates of full accelerated decontrol. The REFCUR85 and REFFUL82 values used in WAIFM and the way they were estimated are described in detail in the Annex.

In addition to changing the nine sets of energy variables to make them consistent with the GMES estimates, three other important changes were made. First, oil imports in REFFUL82 were adjusted. GMES estimates oil consumption in each of the two scenarios. Oil consumption is initially reduced by accelerating decontrol of natural gas prices. The difference in oil consumption between the two cases is assumed to be reflected in a change in oil imports. Oil imports in the WAIFM simulation of REFFUL82 were changed to reflect the difference in oil consumption between the GMES simulations of REFCUR85 and REFFUL82.

Second, investment in natural gas mining was changed to reflect the additional investment estimated to be required to achieve the expected increase in gas production following accelerated decontrol. DOE estimates of the level of investment associated with the expected change in gas production were used to adjust the REFFUL82 level of investment in the gas mining sector in WAIFM.

Third, input-output coefficients in the interindustry matrix were changed to reflect changes in oil and gas use in the industrial and commercial sectors. This change requires somewhat more explanation than the two described above.

Gas users can be divided into four groups: industrial, commercial, residential, and electric utility. Residential and electric utility gas consumption are explicit variables in WAIFM and were set to match GMES estimates. The levels of industrial and commercial gas use are not explicit variables in WAIFM and had to be adjusted in a different manner.

Estimates of industrial and commercial gas use in WAIFM are determined by the input-output coefficients of the 32 industrial and 20 commercial sectors. An input-output table shows for each output how much of each primary input and each intermediate input is required to produce one unit of output. It is an array of input-output coefficients, each one of which shows the amount of a given input required to produce one unit of a given output. Each sector has an input-output coefficient that describes how much gas is required to produce an amount of the output of that sector worth one dollar in 1972. To determine gas use, these input-output coefficients are multiplied by the levels of gross outputs of the sectors. In WAIFM, both gross outputs and the input-output coefficients are endogenous and vary from one simulation to another. The input-output coefficients are functions of relative prices of the different inputs, and the gross outputs are determined by final demand and the input-output coefficients.

Initially, "naive case" simulations of REFCUR85 and REFFUL82 were developed with all changes listed above, excluding the adjustments of gas use in the industrial and commercial sectors. With the naive case values for the input-output coefficients and gross outputs, industrial and commercial gas use was calculated. The input-output coefficients were then adjusted so that changes in industrial and commercial gas use between the WAIFM simulations of current policy and accelerated decontrol matched the changes in the GMES estimates of industrial and commercial gas use. The methodology is described in detail in the Annex.

Adjusting the input-output coefficients was an important aspect of the simulation. WAIFM does not accurately forecast the level of industrial and commercial gas use that is likely to occur after the elimination of fuel use restrictions and curtailments. The elimination of these restrictions will allow those gas users who value gas the most to purchase it. The allocation of energy resources will be more efficient, and the cost of energy inputs will decrease.

Major adjustments were made to the input-output coefficients to reflect these anticipated effects of decontrol. Industrial and commercial gas use was increased approximately 17 percent in the REFFUL82 simulation, and refined petroleum use was decreased by a BTU-equivalent amount. Since gas remains cheaper than oil in all simulations, the switch from oil to gas reduced energy costs and therefore reduced the inflationary impacts and real GNP losses associated with decontrol.

4. RESULTS OF THE SIMULATIONS

This section reports in some detail the results of simulation of the behavior of the economy under the current policy leading to partial decontrol in 1985 and under a policy of full decontrol in 1982. The simulations reported here assume that no explicit changes in fiscal or monetary policy accompany decontrol. As explained below, this implies that increased tax revenues resulting from decontrol are not spent by the government but, rather, are used to reduce the deficit. Simulations of the economic effects of decontrol accompanied by changes in taxes or government spending to offset the increased tax revenues are discussed in Section 5.

Decontrol of natural gas prices may significantly affect economic performance in the years immediately following deregulation. Over a longer period, however, the timing of deregulation (1982 versus 1985) will have a relatively small impact on the growth path of the economy.

A. Price Effects

Increased residential gas costs will directly increase the Consumer Price Index and the GNP deflator. Increased gas costs to commercial, industrial, and electric utility users will raise average price levels as gas-using producers attempt to pass their increased costs on to final consumers. Tables 2 and 3 present the

TABLE 2

IMPLICIT GNP DEFLATOR
(1972 = 100.0)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	193.3	193.3	0.0	0.0
1982	209.2	214.1	4.9	2.3
1983	225.4	231.5	6.1	2.7
1984	243.1	250.2	7.1	2.9
1985	266.5	269.3	2.8	1.1
1986	286.4	288.0	1.7	0.6
1987	306.8	307.6	0.8	0.3
1988	327.9	328.7	0.8	0.2
1989	350.8	350.9	0.2	0.1
1990	375.1	375.4	0.4	0.1

TABLE 3

IMPLICIT GNP DEFLATOR - RATE OF CHANGE
(Percent)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	9.0	9.0	0.0	0.0
1982	8.2	10.7	2.5	30.9
1983	7.7	8.1	0.4	4.8
1984	7.9	8.1	0.2	3.0
1985	9.6	7.7	-2.0	-20.5
1986	7.5	6.9	-0.5	-6.8
1987	7.1	6.8	-0.3	-4.6
1988	6.9	6.9	-0.0	-0.5
1989	7.0	6.8	-0.2	-2.9
1990	6.9	7.0	0.0	0.7

REFCUR85 = Current Policy - NGPA Decontrol
REFFUL82 = Full Accelerated Decontrol in 1982

estimated impacts on inflation as measured by the GNP deflator and its rate of change. The rate of inflation as measured by the rate of change in the Consumer Price Index is given in Table 4.

TABLE 4

CONSUMER PRICE INDEX - RATE OF CHANGE
(Percent)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	10.2	10.2	-	-
1982	7.7	10.4	2.7	26.0
1983	7.7	8.0	0.3	3.8
1984	7.6	7.7	0.1	1.3
1985	9.7	7.4	-2.3	-31.1
1986	7.0	6.5	-0.5	-7.7
1987	6.5	6.4	-0.1	-1.6
1988	6.4	6.5	0.1	1.5
1989	6.6	6.5	-0.1	-1.5
1990	6.7	6.8	0.1	1.5

Decontrol of natural gas prices adds two to two and one-half percentage points to the rate of inflation in the year in which it occurs, whether 1982 or 1985. Full decontrol in 1982 increases the rate of increase of the GNP deflator 2.5 percentage points over the 1982 current policy value. However, inflation is less in 1985-1989 in the full, accelerated decontrol case than in the NGPA case. The level of the price index in the full decontrol case remains slightly above the NGPA decontrol case, but by 1987 the difference in the price level between the alternative cases is insignificant.

The rate of change in the GNP deflator (Table 3) illustrates the year-by-year impacts of decontrol alternatives on the rate of inflation. It shows the symmetrical price effects of decontrol in 1982 versus decontrol in 1985. The year of decontrol in both scenarios is the year of greatest price impact. The rate of inflation in 1982 is 2.5 percentage points greater in the 1982 decontrol case than in the current policy case. In 1985 it is 2.0 percentage points greater in the current policy case than in the accelerated decontrol case. While the year of decontrol is the year of greatest impact, the second and third years following decontrol also exhibit signficant price effects. The effects in these years are about one-fourth to one-sixth the magnitude of the first year's effects.

The impacts of higher natural gas prices are transmitted to final demand prices via the input-output sector of WAIFM. The changes in the GNP deflator are the end result of a series of cost and product price changes. Higher gas costs affect both final consumers and intermediate users of gas. Energy costs for gas-using producers rise to the extent that producers cannot substitute other fuels and non-energy inputs for gas. However, to the extent that decontrol and the relaxation of curtailments gives some producers access to gas at a lower cost than alternative fuels, production costs fall. In the WAIFM and GMES simulations, the sum of these offsetting changes is positive. Total energy costs rise as a result of decontrol.

In WAIFM, all cost changes are passed through to the final product prices immediately. Consumers must pay higher gas bills and face higher prices for other goods and services. These direct and indirect price effects are only part of the final price increase. Seeing their real income fall, workers demand higher wages. Wage increases, in turn, increase the costs of production and product prices in future periods, generating a wage-price spiral.

B. Output Effects

The increase in prices reduces real incomes. Since wage increases do not occur immediately, the decline in real income is not reversed immediately, and consumption and saving fall. Reductions in consumption lead to reductions in output, employment, and income. The reductions in income lead to further reductions in consumption and in investment.

Tables 5 and 6 present estimates of real GNP and growth in real GNP in the accelerated decontrol case and in the current policy reference case. Real GNP is slightly lower in the accelerated decontrol case relative to the current policy case for three years following the date of the decontrol, until decontrol occurs under NGPA in 1985. Real GNP losses are only temporary. As the economy recovers from the effects of the initial price increase and begins to realize the efficiency gains, GNP in the accelerated decontrol case surpasses that in the current policy case. In 1985, GNP in the full decontrol case exceeds that in the current policy reference case. Over the period 1982-1988, the undiscounted sum of estimated GNP losses from accelerated decontrol is $9 billion.

These results are consistent with economic theory and with common experience with price controls. Any good that is artificially controlled is not usually allocated in the most efficient manner. Some users who would be willing to pay higher prices for a commodity are not able to purchase it, while other

TABLE 5

REAL GROSS NATIONAL PRODUCT
(Billion 1972 Dollars)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	1,512.9	1,512.9	0.0	0.0
1982	1,555.6	1,549.4	-6.6	-0.4
1983	1,614.9	1,609.2	-5.7	-0.4
1984	1,685.4	1,682.1	-3.3	-0.2
1985	1,728.3	1,735.2	6.9	0.4
1986	1,788.1	1,783.6	-4.5	-0.3
1987	1,837.4	1,839.2	1.8	0.1
1988	1,895.5	1,897.8	2.4	0.1
1989	1,956.8	1,957.0	0.1	0.0
1990	2,025.0	2,020.4	-4.6	-0.2

TABLE 6

GROWTH IN REAL GROSS NATIONAL PRODUCT
(Percent)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	2.17	2.17	0.00	0.00
1982	2.85	2.41	-0.44	-15.39
1983	3.79	3.86	0.07	1.95
1984	4.37	4.53	0.17	3.88
1985	2.55	3.15	0.61	23.82
1986	3.46	2.79	-0.67	-19.28
1987	2.76	3.11	0.36	12.91
1988	3.16	3.19	0.03	1.01
1989	3.24	3.11	-0.12	-3.79
1990	3.49	3.24	-0.24	-7.01

users who would be unwilling or unable to pay the market clearing price are consuming available supplies. Reallocation of gas to those willing to pay the market price, for whom it has a higher value, increases efficiency and potential output. Adjustment problems do, however, impose real costs on users and must be deducted from the efficiency gains. The WAIFM simulations support this thesis. After the initial year of losses, growth rates in five out of eight years after decontrol are higher in the accelerated decontrol case than in the current policy scenario.

As was the case with the price effects, the impact of NGPA decontrol in 1985 on GNP is smaller than the impact of full decontrol in 1982. This result is partly due to the fact that decontrol in 1985 is not full decontrol.

As Table 5 shows, the difference in GNP between the two decontrol cases appears to have a cyclical pattern in the WAIFM simulations. GNP in the accelerated decontrol case dips below that of the current policy case in 1986 and 1990. To ascertain what causes the cyclical pattern, GNP must be disaggregated into its component parts. GNP changes are the sum of changes of its components: consumption, investment, government purchases, exports, and imports.

(1) Consumption

Table 7 shows the effects of accelerated decontrol on consumption. Tables 8-10 disaggregate consumption into consumption of durables, nondurables, and services.

Consumption of a particular class of goods in WAIFM is generally specified to be a function of employee compensation, real personal disposable income, and the price of the consumption good relative to other consumer goods. Consumption in the accelerated decontrol case falls because real disposable income falls and, generally, the relative price of the consumer good increases. Wage increases will offset somewhat these negative influences, but generally not until later periods.

Not all components of consumption (durables, nondurables, and services) change in exactly the same way. The functions for the different consumption variables may have different specifications, or the estimates of the elasticities of demand for the different goods may differ.

Comparison of Tables 7-10 shows that consumption of durable goods initially is affected the most by accelerated decontrol. Declines in consumption of durables, both absolute and proportional, are the greatest for the first three years after decontrol. Durable goods in WAIFM include autos and parts, furniture and household

TABLE 7

CONSUMPTION
(Billion 1972 Dollars)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	961.9	961.9	0.0	0.0
1982	987.0	982.0	-5.0	-0.5
1983	1,020.6	1,016.3	-4.3	-0.4
1984	1,052.4	1,047.4	-5.0	-0.5
1985	1,076.1	1,076.2	0.1	0.0
1986	1,112.6	1,109.2	-3.3	-0.3
1987	1,145.4	1,144.3	-1.1	-0.1
1988	1,179.2	1,177.3	-1.9	-0.2
1989	1,214.7	1,211.8	-2.9	-0.2
1990	1,252.1	1,247.6	-4.5	-0.4

TABLE 8

CONSUMPTION - DURABLES

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	139.5	139.5	0.0	0.0
1982	144.1	140.6	-3.4	-2.4
1983	154.3	152.6	-1.7	-1.1
1984	161.5	160.1	-1.5	-0.9
1985	162.9	165.6	2.7	1.7
1986	172.7	172.7	-0.1	-0.0
1987	179.9	181.2	1.4	0.8
1988	186.2	186.9	0.7	0.4
1989	191.7	191.7	0.0	0.0
1990	197.9	196.7	-1.1	-0.6

TABLE 9

CONSUMPTION - NONDURABLES
(Billion 1972 Dollars)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	369.4	369.4	0.0	0.0
1982	378.3	377.8	-0.5	-0.1
1983	390.3	389.3	-1.0	-0.3
1984	400.2	398.4	-1.8	-0.4
1985	406.3	404.6	-1.7	-0.4
1986	417.5	414.9	-2.6	-0.6
1987	425.9	423.9	-2.0	-0.5
1988	434.3	432.4	-1.9	-0.4
1989	443.7	441.9	-1.9	-0.4
1990	454.2	452.2	-2.0	-0.4

TABLE 10

CONSUMPTION - SERVICES
(Billion 1972 Dollars)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	452.9	452.9	0.0	0.0
1982	464.6	463.6	-1.0	-0.2
1983	475.9	474.4	-1.6	-0.3
1984	490.7	488.9	-1.8	-0.4
1985	506.9	505.9	-0.9	-0.2
1986	522.4	521.7	-0.7	-0.1
1987	539.7	539.2	-0.5	-0.1
1988	558.7	558.0	-0.7	-0.1
1989	579.3	578.2	-1.0	-0.2
1990	600.1	598.7	-1.3	-0.2

equipment, and other durables. Within this group new car consumption declines the most. New car purchases decline sharply because of the changes in income, operating costs, interest rates, and auto prices.

Nondurable consumption also declines, but less than durable consumption. Nondurable consumption levels are also specified to be functions of relative prices, change in compensation, and real disposable income, but do not exhibit the cyclical swings that consumption of durable goods do. Nondurable purchases, such as food, cannot be deferred, as can durable purchases. For similar reasons, consumption of services follows the same pattern as nondurables.

(2) Investment

Accelerated natural gas decontrol also has significant effects on investment. Table 11 shows the effects on total investment, and Tables 12-13 show the effects on investment in nonresidential structures and equipment and in residential structures, respectively.[1] Investment in WAIFM is specified to be determined by output, the user cost of capital, and the lagged value of the capital stock. The lagged capital stock term in the investment equations causes cyclical swings in investment. A large increase in investment in one year will increase the capital stock and lead to a smaller level of investment in subsequent years.

The cyclical pattern in relative investment between the two cases appears to be approximately four years in length. In 1982, the amount of investment in the full decontrol case is about $.25 billion lower than the current policy case. Investment recovers in 1983 and remains above current policy levels for all years except 1986 and 1990. These cyclical downswings appear to be driven by declines in residential investment in the accelerated decontrol case relative to current policy levels. Residential investment in REFFUL82 is lower than in REFCUR85 in 1982-1984, 1986, and 1990. The reduction in residential investment is due in part to increases in interest rates. Only in 1986 and 1990, however, are the declines in residential investment sufficient to reduce total investment.

Nonresidential investment responds to accelerated decontrol differently from residential investment. Investment in oil and gas mining, which was estimated exogenously and imposed on the model, dominates the changes. Nonresidential investment is higher in the accelerated decontrol scenario in 1982-1985 and then falls below the current policy case as decontrol in 1985 under NGPA occurs, bringing with it an increase in investment in gas mining.

---

[1] The third and smallest component of investment, inventory change, is not shown.

TABLE 11

INVESTMENT
(Billion 1972 Dollars)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	213.1	213.1	0.0	0.0
1982	224.2	224.0	-0.2	-0.1
1983	244.2	245.3	1.1	0.5
1984	272.0	276.6	4.9	1.8
1985	277.3	286.0	8.7	3.1
1986	287.9	287.1	-0.8	-0.3
1987	292.8	296.2	3.4	1.2
1988	306.0	310.8	4.8	1.6
1989	321.4	324.7	3.3	1.0
1990	340.5	340.5	-0.0	-0.0

TABLE 12

NONRESIDENTIAL INVESTMENT
(Billion 1972 Dollars)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	161.7	161.7	0.0	0.0
1982	166.0	168.4	2.4	1.5
1983	172.2	177.2	5.0	2.9
1984	180.4	187.8	7.4	4.1
1985	186.1	188.6	2.5	1.4
1986	195.3	195.1	-0.2	-0.1
1987	203.4	202.2	-1.2	-0.6
1988	212.3	211.4	-0.8	-0.4
1989	224.8	224.8	-0.1	-0.0
1990	237.2	237.3	0.1	0.1

TABLE 13

INVESTMENT - RESIDENTIAL STRUCTURES
(Billion 1972 Dollars)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	47.3	47.3	-0.0	-0.0
1982	48.5	46.6	-1.9	-3.9
1983	57.3	53.9	-3.4	-6.0
1984	72.2	69.6	-2.6	-3.6
1985	72.8	77.8	4.9	6.8
1986	73.9	73.5	-0.4	-0.6
1987	71.0	75.4	4.4	6.2
1988	74.8	80.1	5.2	7.0
1989	75.9	79.6	3.7	4.9
1990	81.5	81.2	-0.3	-0.4

(3) Government Purchases

Real government spending in WAIFM is exogenous. Nominal government spending will change with changes in the price level. Table 14 displays the estimated level of real government spending in both scenarios.

(4) Exports and Imports

U.S. exports are the fourth major GNP component that may be affected by accelerated natural gas decontrol. Table 15 shows the effects on total exports. Exports are a function of the price of U.S. goods relative to foreign goods and of foreign economic activity. In these simulations, foreign prices and economic activity do not change as a result of accelerated decontrol of U.S. natural gas prices. The effects on exports result from changes in U.S. export prices. Export prices are calculated in the same way as other final demand deflators. By raising the level of U.S. prices initially, accelerated decontrol raises most export prices. The difference in prices is greatest in 1982, diminishes greatly in 1985, but persists throughout the simulation period. Consequently, exports in every period are lower in the accelerated decontrol case than in the current policy case.

TABLE 14

GOVERNMENT SPENDING
(Billion 1972 Dollars)

Year	REFCUR85	REFFUL82
1981	292.7	292.7
1982	297.9	297.9
1983	297.2	297.2
1984	307.4	307.4
1985	318.3	318.3
1986	328.1	328.1
1987	337.6	337.6
1988	346.8	346.8
1989	356.5	356.5
1990	367.4	367.4

TABLE 15

EXPORTS
(Billion 1972 Dollars)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	159.5	159.5	0.0	0.0
1982	158.5	156.8	-1.7	-1.1
1983	168.1	165.8	-2.3	-1.3
1984	172.6	170.1	-2.5	-1.4
1985	177.0	176.2	-0.9	-0.5
1986	183.3	182.8	-0.4	-0.2
1987	189.3	189.0	-0.3	-0.2
1988	196.5	196.2	-0.3	-0.1
1989	203.2	203.1	-0.1	-0.1
1990	209.9	209.7	-0.2	-0.1

Imports of goods and services will also be affected significantly by full accelerated natural gas decontrol. The effect on total imports is shown in Table 16. WAIFM's specification of the determinants of import levels is similar to that for exports. Imports are a function of the domestic income level and the price of foreign goods relative to domestic import-competing goods. The main difference between the import equations and the export equations is that all variables which influence imports are endogenous. In the export equations, only the price of exports was endogenous. As a result, imports may be more sensitive to the effects of natural gas decontrol.

Two opposing changes will affect imports in the initial years after decontrol. Higher natural gas prices make U.S. goods relatively more expensive, so imports would tend to increase. This effect, however, is offset by the decline in U.S. income which reduces the demand for imports. The income effect prevails in 1982, and imports are lower in the accelerated decontrol case than in the current policy case in that year. In the other years, except 1986 and 1990, imports are greater in the accelerated decontrol case. The differences between the cases are very small.

A major component of imports that changes due to accelerated natural gas decontrol is oil imports. Accelerated decontrol increases gas use, displacing foreign oil. Accelerated decontrol also initially depresses the economy and in this way reduces demand for petroleum. Table 17 displays the effects of accelerated decontrol on oil imports.

C. Profits and Personal Income

Decontrol has substantial effects on other macroeconomic variables. The large increases in the wellhead price of natural gas generate large increases in the profits of gas producers. While profits in some industrial sectors may decrease if cost increases cannot be passed through to consumers, the huge transfer to gas producers from consumers will raise total corporate profits.[1] Table 18 shows the effects of decontrol on total pre-tax corporate profits. Corporate profits before taxes increase by 46 billion current dollars in 1982, $31 billion in 1983, and $34 billion in 1984 in the accelerated decontrol scenario relative to the current policy case. The crude oil and natural gas mining sector is the chief recipient of the increase in profits. The increase in profits in that sector in 1982 is approximately $44 billion.

---

[1] Estimated profits are reduced for the following industries in 1982 under accelerated decontrol: agriculture ($1.4 billion), residential construction (1.6), motor vehicles (1.0), petroleum refining (0.2), metal mining (0.5), coal mining (0.6), and nonmetal mining (0.1).

TABLE 16

IMPORTS
(Billion 1972 Dollars)

Year	REFCUR85	REFFUL82	Difference	% Difference
1980	-	-	-	-
1981	114.2	114.2	0.0	0.0
1982	111.5	111.2	-0.3	-0.3
1983	115.2	115.5	0.3	0.3
1984	118.9	119.6	0.6	0.5
1985	120.4	121.5	1.1	0.9
1986	123.8	123.6	-0.1	-0.1
1987	127.7	127.9	0.2	0.2
1988	133.0	133.2	0.2	0.2
1989	139.0	139.1	0.2	0.1
1990	145.0	144.9	-0.1	-0.0

TABLE 17

CRUDE OIL IMPORTS
(Million Barrels per Day)

Year	REFCUR85	REFFUL82	Difference	% Difference
1980	-	-	-	-
1981	4.7	4.7	0.0	0.0
1982	5.0	4.7	-0.3	-6.0
1983	5.2	4.6	-0.6	-10.9
1984	5.2	4.5	-0.7	-13.6
1985	5.3	4.8	-0.5	-9.6
1986	5.4	5.0	-0.4	-7.9
1987	5.4	5.2	-0.2	-3.3
1988	5.4	5.3	-0.1	-1.8
1989	5.4	5.4	0.0	0.2
1990	5.4	5.5	0.0	0.5

TABLE 18

CORPORATE PROFITS - BEFORE TAXES
(Billion Current Dollars)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	225.9	225.9	-0.0	-0.0
1982	258.5	304.9	46.4	17.9
1983	314.6	346.1	31.5	10.0
1984	391.1	424.7	33.6	8.6
1985	478.1	465.3	-12.8	-2.7
1986	488.8	477.4	-11.4	-2.3
1987	505.6	502.3	-3.3	-0.6
1988	545.9	547.5	1.6	0.3
1989	596.4	587.2	-9.2	-1.5
1990	643.5	634.7	-8.8	-1.4

Profits changes will change stockholders' incomes. WAIFM, however, distributes only about half of after-tax profits to dividends, and the distribution occurs with a lag. As a consequence, the change in real personal disposable income is dominated by worker's income losses, especially in the years immediately after decontrol. Table 19 lists the net effects on real disposable income.

TABLE 19

REAL DISPOSABLE INCOME
(Billion 1972 Dollars)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	1,043.4	1,043.4	0.0	0.0
1982	1,077.1	1.062.6	-14.5	-1.4
1983	1,115.3	1,102.3	-13.0	-1.2
1984	1,149.9	1,139.2	-10.8	-0.9
1985	1,153.2	1,155.8	2.7	0.2
1986	1,185.8	1,183.3	-2.5	-0.2
1987	1,223.6	1,220.7	-2.8	-0.2
1988	1,261.6	1,257.5	-4.1	-0.3
1989	1,301.8	1,296.6	-5.2	-0.4
1990	1,339.3	1,331.9	-7.4	-0.6

D. Employment and the Labor Force

One reason workers' disposable income falls is the decline in employment brought on by accelerated natural gas decontrol. WAIFM determines employment levels by first estimating output by applying the estimated final demands to the input-output sector, and then using the sectoral production functions to determine the employment necessary to produce that output. Table 20 illustrates how employment changes lag real GNP and output changes. Changes in output are not immediately reflected in changes in employment. Producers do not generally release workers immediately when output declines because of the human capital firms have invested in the workers and the costs of hiring and firing. Producers also do not rehire workers immediately when output increases.

TABLE 20

EMPLOYMENT
(Millions of Workers)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	100.5	100.5	0.0	0.0
1982	102.0	101.8	-0.2	-0.2
1983	103.9	103.6	-0.2	-0.2
1984	106.5	106.4	-0.1	-0.1
1985	107.7	107.9	0.2	0.2
1986	109.7	109.7	0.0	0.0
1987	111.9	112.0	0.1	0.1
1988	113.6	113.8	0.2	0.1
1989	115.3	115.4	0.1	0.1
1990	117.3	117.3	-0.1	-0.1

In many macroeconomic models, the civilian labor force is exogenous. In WAIFM, the size of the civilian labor force is estimated by age and sex. The specifications of the equations differ by age and sex because these demographic characteristics influence labor force participation. Variables that influence the size of the civilian labor force include unemployment and income. WAIFM includes these variables to attempt to capture both the cyclical "added-worker" effect and the "discouraged worker" effect. The "added-worker" effect refers to an increase in the labor force that may occur when unemployment increases if spouses or other family members enter the labor force to attempt to replace the lost income of primary workers who have lost their jobs. The "discouraged worker" effect refers to a decrease in the labor force that may occur when unemployment increases if individuals drop out of the labor force because they cannot find a job for a long time. Table 21 shows the changes in the civilian labor force. The changes are very small. The discouraged worker effect appears to dominate the added worker effect.

TABLE 21

CIVILIAN LABOR FORCE
(Millions)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	108.5	108.5	0.0	0.0
1982	110.4	110.4	0.1	0.0
1983	112.1	111.9	-0.1	-0.1
1984	113.6	113.5	-0.1	-0.1
1985	115.1	115.0	-0.1	-0.1
1986	116.5	116.5	0.0	0.0
1987	118.1	118.2	0.0	0.0
1988	119.6	119.6	0.0	0.0
1989	121.2	121.2	0.0	0.0
1990	122.6	122.6	0.0	0.0

Changes in the unemployment rate reflect changes in GNP between the two cases. The unemployment rate is shown in Table 22. Unemployment rises by about 200 thousand in 1982, adding 0.2 percentage points to the unemployment rate. Unemployment remains greater in 1983 and 1984 in the accelerated decontrol case, but is lower in 1985 and 1987-1989 as the economy expands.

E. Taxes and the Government Budget Balance

Increases in corporate profits will lead to increased corporate profits taxes in addition to the increases in distributed earnings mentioned above. The marginal tax rate on corporate profits in the gas mining sector in WAIFM is approximately 42 percent, so the changes in corporate profits taxes brought on by accelerated decontrol are about 42 percent of the changes in corporate profits. These changes are shown in Table 23.

Personal taxes also change because of accelerated decontrol. Real economic activity is down and prices are up in the early years after decontrol. These phenomena have opposing effects on taxes. Income declines reduce personal tax payments, but inflation will force employed workers into higher tax brackets and increase tax payments. The net effect, shown in Table 24, is to increase personal tax payments in current dollars for the full decontrol case in each year.

TABLE 22

UNEMPLOYMENT RATE
(Percent)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	7.4	7.4	0.0	0.0
1982	7.6	7.8	0.2	2.8
1983	7.3	7.4	0.1	1.5
1984	6.3	6.3	0.0	0.5
1985	6.5	6.1	-0.3	-4.8
1986	5.8	5.9	0.0	0.4
1987	5.3	5.2	-0.1	-1.2
1988	5.0	4.9	-0.1	-2.5
1989	4.9	4.8	-0.1	-1.8
1990	4.3	4.4	0.1	2.0

TABLE 23

CORPORATE PROFITS TAXES
(Billion Current Dollars)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	62.7	62.7	0.0	0.0
1982	75.3	94.7	19.3	25.7
1983	94.1	106.9	12.8	13.6
1984	114.3	127.7	13.4	11.8
1985	139.0	132.4	-6.7	-4.8
1986	127.3	122.0	-5.2	-4.1
1987	118.9	117.5	-1.4	-1.2
1988	122.7	123.5	0.9	0.7
1989	129.1	125.2	-3.9	-3.0
1990	130.5	126.8	-3.8	-2.9

In WAIFM real government spending is exogenous and, consequently, is unchanged between the two simulations. Nominal spending is greater in the decontrol simulation as a result of the increase in inflation. However, the sharp increases in taxes more than offset the inflationary increases in nominal government spending. Consequently, the government budget deficit is reduced in all years following decontrol in 1982. Because the price level remains higher and real income is greater in the accelerated decontrol case in each year after 1984 (except 1986 and 1990) the net change in the government budget balance remains positive in each year, even after decontrol occurs in the current policy case in 1985. These effects are shown in Table 25.

F. Money Supply and Interest Rates

The previous discussion has dealt solely with real economic effects of decontrol of natural gas. There are also many financial effects that may occur because of accelerated decontrol. Three variables which may be affected significantly are the money supply, short-term interest rates, and long-term interest rates. These are also the most significant financial variables which interact with the real side of the model.

Change in the money supply (M2 definition = currency + demand deposits + time deposits) in WAIFM is positively influenced by changes in the price level and the level of real GNP. Consequently, decontrol will have offsetting effects, increasing inflation but reducing real GNP. Table 26 gives the net effects of decontrol on the money supply. M2 is higher in all years except 1990. In most years, M2 is greater because, with accelerated decontrol, increases in the price level proportionally exceed reductions in GNP. In 1990, real GNP is lower and the GNP deflator is about the same in the two cases, so the money supply is lower.

Changes in real GNP and in the GNP deflator determine changes in nominal GNP, shown in Table 27. The increase in the price level increases nominal GNP in the accelerated decontrol case in all years except 1990.

Short term interest rates in WAIFM are determined by the rate of inflation and the ratio of nominal GNP to the money supply. This specification attempts to capture the impacts of both inflation and real growth on the interest rate. Full accelerated decontrol raises the price level so, with a lag, short term interest rates increase relative to those of the current policy scenario. Then, in later years, as the rate of inflation slows down, interest rates under accelerated decontrol begin to drop below those of the NGPA scenario. The primary interest rate in WAIFM is the rate on large time deposits--negotiable certificates of deposit (CDs). This

TABLE 24

PERSONAL TAX PAYMENTS - FEDERAL
(Billion Current Dollars)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	295.1	295.1	0.0	0.0
1982	302.8	308.4	5.6	1.9
1983	293.7	303.2	9.5	3.2
1984	300.3	313.2	12.9	4.3
1985	348.0	362.1	14.1	4.0
1986	405.5	414.2	8.8	2.2
1987	463.5	471.8	8.2	1.8
1988	526.7	534.8	8.1	1.5
1989	597.4	604.9	7.4	1.2
1990	672.2	679.5	7.2	1.1

TABLE 25

FEDERAL GOVERNMENT SURPLUS
(Billion Current Dollars)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	-61.9	-61.9	0.0	-0.0
1982	-78.6	-60.8	17.9	-22.7
1983	-83.5	-69.0	14.5	-17.3
1984	-68.0	-50.0	18.0	-26.4
1985	-17.7	-8.9	8.8	-49.6
1986	-3.8	0.7	4.5	-118.9
1987	-10.3	3.2	13.5	-131.0
1988	-4.7	15.1	19.8	-418.6
1989	5.4	21.1	15.7	292.5
1990	44.4	56.2	11.8	26.6

TABLE 26

MONEY SUPPLY - M2 DEFINITION
(Billion Current Dollars)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	1,761.3	1,761.3	0.0	0.0
1982	1,936.4	1,953.0	16.6	0.9
1983	2,153.6	2,200.1	46.5	2.2
1984	2,481.8	2,545.8	64.0	2.6
1985	2,814.0	2,877.4	63.4	2.3
1986	3,144.9	3,168.0	23.1	0.7
1987	3,478.5	3,493.9	15.4	0.4
1988	3,829.2	3,843.9	14.7	0.4
1989	4,212.3	4,220.4	8.1	0.2
1990	4,659.9	4,655.9	-4.0	-0.1

TABLE 27

NOMINAL GROSS NATIONAL PRODUCT
(Billion Current Dollars)

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	2,924.8	2,924.8	0.0	0.0
1982	3,254.0	3,317.2	62.2	1.9
1983	3,639.5	3,724.4	84.9	2.3
1984	4,096.8	4,208.5	111.6	2.7
1985	4,606.2	4,673.4	67.2	1.5
1986	5,120.7	5,137.4	16.7	0.3
1987	5,636.3	5,657.1	20.8	0.4
1988	6,214.8	6,237.7	22.9	0.4
1989	6,863.6	6,867.7	4.2	0.1
1990	7,595.2	7,585.3	-10.0	-0.1

interest rate is shown in Table 28. All other interest rates, both short and long term, are tied to this short term rate. Long term bond rates, for example, are a weighted average of the short term CD rate. Changes in the long term bond rate follow changes in the short term rates, as shown in Table 29.

5. SIMULATIONS OF TAX REDUCTION AND GOVERNMENT SPENDING INCREASE

The simulations of the impact of accelerated full decontrol of natural gas prices indicated that accelerated decontrol would increase tax revenues. The assumption behind the simulations reported above is that tax rates and government spending remain unchanged. Consequently, the increase in tax collections serves to increase the federal budget balance, i.e., reduce the deficit. The increase in taxes, unmatched by an increase in government spending or reduction in other taxes, has a contractionary influence on the economy. Much of the fall in GNP may be attributable to this contractionary effect of the increase in taxes. In order to examine the economic effects of gas decontrol alone, adjusting for the increase in taxes, two additional simulations were developed. In the first, personal taxes were reduced by an amount sufficient to leave the federal budget balance unchanged between the two policy cases, i.e., to keep the deficit the same in REFFUL82 as in REFCUR85. In the second, government spending was increased by an amount sufficient to leave the budget balance unchanged.

A. PERSONAL TAX CUT

As described above, accelerated natural gas price decontrol increases personal and profits taxes relative to current policy. The personal tax cut simulation, called REFFUL82PTX was developed by decreasing personal taxes in the REFFUL82 case by the exact amount of the increased federal government surplus. This amount is shown in the column labeled "Difference" in Table 25. Tax cuts in 1982, for example, totaled $17.856 billion. Personal taxes were reduced in all years. GNP and price level estimates from this simulation, REFFUL82PTX, are shown in Tables 30 and 31.

As Table 30 shows, a personal tax cut can completely offset the negative GNP effects resulting from accelerated decontrol. Furthermore, the WAIFM results show little change in inflation due to this tax cut. Inflation declines slightly because the tax cut increases output and productivity.

B. CHANGE IN GOVERNMENT PURCHASES

The government spending simulation was constructed in a similar manner to the personal tax cut simulation. Government purchases were changed by an amount exactly equal to the difference in the

TABLE 28

SHORT-TERM INTEREST RATE - LARGE TIME DEPOSITS (NEGOTIABLE CD'S) ALL INSTITUTIONS

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	16.82	16.82	0.00	0.00
1982	16.60	18.51	1.91	11.52
1983	12.96	14.01	1.06	8.15
1984	10.80	11.64	0.83	7.73
1985	10.73	9.68	-1.04	-9.73
1986	9.93	8.87	-1.05	-10.61
1987	9.04	8.32	-0.72	-7.93
1988	8.60	8.17	-0.42	-4.94
1989	8.32	8.00	-0.32	-3.80
1990	8.13	8.01	-0.12	-1.45

TABLE 29

LONG TERM BOND RATE - MOODY'S CORPORATE, TOTAL

Year	REFCUR85	REFFUL82	Difference	% Difference
1981	15.00	15.00	0.00	0.00
1982	15.57	16.07	0.40	3.21
1983	13.71	14.62	0.91	6.62
1984	11.74	12.82	1.08	9.22
1985	10.80	11.34	0.55	5.13
1986	10.07	9.82	-0.25	-2.47
1987	9.90	9.20	-0.70	-7.07
1988	9.52	8.74	-0.78	-8.16
1989	8.85	8.29	-0.56	-6.35
1990	8.57	8.22	-0.35	-4.07

TABLE 30

EFFECT OF ACCELERATED DECONTROL PLUS PERSONAL TAX CUT ON REAL GROSS NATIONAL PRODUCT
(Billion 1972 Dollars)

Year	REFCUR85	REFFUL82PTX	Difference	% Difference
1981	1,512.9	1,512.9	0.0	0.0
1982	1,556.0	1,563.4	-0.6	-0.0
1983	1,614.9	1,615.9	1.0	0.1
1984	1,685.4	1,691.2	5.8	0.3
1985	1,728.3	1,742.5	14.2	0.8
1986	1,788.1	1,788.4	0.3	0.0
1987	1,837.4	1,848.8	7.4	0.4
1988	1,895.4	1,911.7	10.3	0.5
1989	1,956.8	1,968.1	8.2	0.4
1990	2,025.0	2,027.2	2.2	0.1

TABLE 31

EFFECT OF ACCELERATED DECONTROL PLUS PERSONAL TAX CUT ON IMPLICIT GROSS NATIONAL PRODUCT DEFLATOR
(1972 = 100)

Year	REFCUR85	REFFUL82PTX	Difference	% Difference
1981	193.3	193.3	0.0	0.0
1982	209.2	214.1	4.9	2.3
1983	225.4	231.4	6.0	2.7
1984	243.1	250.2	7.1	3.0
1985	266.5	269.6	3.0	1.1
1986	286.4	288.3	1.9	0.7
1987	306.8	307.8	1.1	0.4
1988	327.9	328.8	0.9	0.3
1989	350.8	350.9	0.1	0.0
1990	375.1	375.4	0.3	0.1

government budget balance in Table 25. This spending change was allocated equally to defense and non-defense purchases. The GNP and GNP deflator results are shown in Tables 32 and 33.

The results indicated that an increase in government purchases equal to the increase in tax collections will offset all negative impacts of accelerated decontrol of natural gas and will have a very small effect on inflation. The increase in government purchases has a larger effect on GNP than the personal tax cut of equal size. This results from the manner in which tax cuts and spending increases flow through the economy. Some proportion of a tax cut will be saved and will not immediately lead to increased expenditures and output. However, a direct increase in government purchases immediately increases total expenditures and aggregate demand by the full amount of the spending increase. If the economy has the capacity to increase output, therefore, an increase in government purchases will increase output more than a reduction in taxes. Inflation is also slightly lower in this case due to higher output and productivity.

6. LIMITATIONS OF THE WHARTON ANNUAL MODEL

The Wharton Annual and Industry Forecasting Model is a powerful analytical tool and can provide valuable insights into the impacts of energy policy changes. However, like any tool, it has limitations. This section briefly reviews several important limitations and discusses how they may affect the decontrol simulation results.

The model is centered around an input-output matrix with relatively fixed coefficients. The embedded input-output system is one source of the model's analytical power. However, use of any input-output system for forecasting requires an assumption that industrial structure and materials use do not change rapidly. Because of the use of the input-output system for price forecasting, changes in costs such as gas costs are immediately reflected in the final product price. Producers absorb none of the cost increases. If, in fact, producers absorb some of the increases in gas costs by reducing profits, the price increases resulting from decontrol may be overstated by the model.

A second limitation of WAIFM is the financial or monetary sector. The financial sector is not closely linked to the real side of the model. Interest rates do not respond rapidly to changes in inflation. Investment does not respond rapidly to interest rate changes. Monetary policy changes will cause almost no changes in real activity for a period of at least three years.

TABLE 32

EFFECT OF ACCELERATED DECONTROL PLUS GOVERNMENT SPENDING INCREASE ON REAL GROSS NATIONAL PRODUCT

(Billion 1972 Dollars)

Year	REFCUR85	REFFUL82GOV	Difference	% Difference
1981	1,512.9	1,512.9	0.0	0.0
1982	1,556.0	1,563.3	7.3	0.5
1983	1,614.9	1,620.8	5.9	0.4
1984	1,685.4	1,695.9	10.5	0.6
1985	1,728.3	1,743.0	14.7	0.8
1986	1,788.1	1,788.8	0.8	0.0
1987	1,837.4	1,848.4	11.0	0.6
1988	1,895.4	1,911.1	15.7	0.8
1989	1,956.8	1,968.2	11.4	0.6
1990	2,025.0	2,028.7	3.6	0.2

TABLE 33

EFFECT OF ACCELERATED DECONTROL PLUS GOVERNMENT SPENDING INCREASE ON GROSS NATIONAL PRODUCT DEFLATOR

(1972 = 100)

Year	REFCUR85	REFFUL82GOV	Difference	% Difference
1981	193.3	193.3	0.0	0.0
1982	209.2	214.1	4.9	2.4
1983	225.4	231.4	6.1	2.7
1984	243.1	250.3	7.2	3.0
1985	266.5	269.6	3.1	1.2
1986	286.4	288.2	1.9	0.6
1987	306.8	307.7	1.0	0.3
1988	327.9	328.6	0.7	0.2
1989	350.8	350.8	0.0	0.0
1990	375.1	375.3	0.2	0.1

A third major aspect that is questionable is the response of the model to expansionary fiscal policy changes. Government spending increases or tax reductions lead to substantial changes in income, but not inflation. In fact, by increasing capacity utilization and productivity, increases in output in WAIFM tend to reduce inflation. This result seems plausible only if the economy is at a very low level of capacity utilization.

For these reasons, the results presented in this report must be carefully interpreted. While the direction and magnitude of the results provide one useful indicator of the potential impacts of decontrol, they are sensitive to the characteristics of the model and the assumptions used. By comparing these results to those obtained from other models and other approaches, policy-makers can develop a well-informed set of estimates of the probable impacts of decontrol and the range of uncertainty.

ANNEX TO ATTACHMENT III

PROCEDURES USED TO SIMULATE THE ECONOMIC EFFECTS OF NATURAL GAS PRICE DECONTROL USING THE WHARTON ANNUAL AND INDUSTRY FORECASTING MODEL

This annex describes how the Wharton Annual and Industry Forecasting Model (WAIFM) was adjusted to simulate the two natural gas price decontrol scenarios. Output from the DOE Gas Market Evaluation System (GMES) was used to develop the inputs to the Wharton model.

The two scenarios that were run were:

REFCUR85 - decontrol of most natural gas in 1985 as provided by the Natural Gas Policy Act of 1978, with end-use restrictions on the use of natural gas by industrial and new electric utilities in place as legislated;

REFFUL82 - decontrol of natural gas in 1982 and elimination of end-use restrictions.

The Wharton Annual Model was adjusted to simulate the effects of decontrol in two stages. First, several endogenous and exogenous variables in WAIFM were adjusted to be consistent with values of corresponding variables estimated by GMES. With the adjusted variables, a first stage simulation of the effects of decontrol was developed. This simulation is referred to below as the Naive Case. Based on the Naive Case, a second stage simulation was developed by adjusting the input-output coefficients in the WAIFM interindustry model.

These additional adjustments were required to simulate accurately the effects of decontrol. The existing WAIFM input-output coefficients, which were estimated over a historic period when natural gas prices were controlled and curtailments prevailed, fail to reflect the increase in natural gas use in the industrial and commercial sectors that is estimated to occur after decontrol and the end of curtailments. This increased industrial and commercial use of gas, largely in place of oil, is one of the major sources of efficiency gains from decontrol. Failure to incorporate these input changes properly, therefore, would mean that one of the major effects of decontrol would be missed.

The first section of this annex describes the adjustments that were made to the Wharton model assuming that the Wharton input-output coefficients were correct (the Naive Case). The second section describes how the coefficients were adjusted to reflect GMES estimates of industrial and commercial gas use (the Standard Case).

I. NAIVE CASE INPUTS

1. Average Wellhead Price

An average of the inter- and intrastate wellhead prices of natural gas was calculated from the GMES estimates. Table A-1 lists these prices for the two scenarios.

TABLE A-1

AVERAGE WELLHEAD PRICE - GMES
(1980 Dollars/Mcf)

Year	REFCUR85	REFFUL82
1980	1.81	-
1981	2.09	-
1982	2.27	4.19
1983	2.42	4.27
1984	2.61	4.44
1985	4.45	4.65
1986	4.59	4.80
1987	4.72	4.92
1988	4.92	5.08
1989	5.13	5.29
1990	5.35	5.50

These values were first converted to current dollars using the Wharton GNP deflator from the October 1981 WAIFM Control Forecast (CNTL1081). The Control deflator with base year of 1972 (=100.0) and a scaler, calculated from this index, which was used to inflate the 1980 dollar values in Table A-1, were as follows:

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PDGNP	177.36	193.18	290.20	225.58	243.52	263.88	285.18	309.38	333.41	358.66	386.08
PDGNP SCALER	1.000	1.089	1.180	1.272	1.373	1.488	1.608	1.744	1.880	2.022	2.177

First, a measurement difference between the GMES model and the Wharton model was corrected. The 1980 GMES value of this series was $1.81/Mcf. The Wharton value of the average wellhead price of natural gas (PUMG131N) was $1.496/Mcf. Both values are estimates of historic data, not forecasts. The two values differ because of differences in where the prices were measured and taxes. The GMES estimates were scaled by 1.496/1.81 for the index used in the first WAIFM run. The values are presented in Table A-2 (in cents per Mcf). The WAIFM control value is also presented for comparison.

TABLE A-2

PUMG131N - AVERAGE WELLHEAD PRICE - WAIFM - RUN1
(Current Cents/Mcf)

Year	CNTL1081	REFCUR85	REFFUL82
1981	180.1	188.2	188.2
1982	211.0	221.3	408.5
1983	246.4	254.4	448.9
1984	285.6	296.2	503.9
1985	392.4	547.2	571.8
1986	558.5	610.0	637.9
1987	800.0	680.5	709.3
1988	950.3	764.4	789.3
1989	1,125.8	857.4	884.2
1990	1,330.0	962.6	989.6

The GMES estimates reported in Table A-2 for the different scenarios differ significantly from the WAIFM control values. These differences generated different estimates of the GNP deflator in the first simulations. The new estimated GNP deflator was then used to calculate the current dollar inputs to the final simulations. The final values of PUMG131N that were used in the simulations are displayed in Table A-3.

TABLE A-3

PUMG131N - AVERAGE WELLHEAD PRICE - WAIFM - FINAL
(Current Cents/Mcf)

Year	REFCUR85	REFFUL82
1981	188.3	-
1982	221.3	418.2
1983	254.1	461.1
1984	295.4	518.4
1985	551.6	584.2
1986	610.5	644.5
1987	672.8	705.1
1988	749.7	778.1
1989	836.3	865.0
1990	932.7	962.0

The scalers that were used are:

PDGNP SCALERS	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
REFCUR85	1.000	1.090	1.179	1.270	1.369	1.500	1.610	1.725	1.844	1.972	2.109
REFFUL82	1.000	1.090	1.208	1.306	1.413	1.520	1.624	1.734	1.853	1.978	2.116

2. Industrial, Commercial, and Electric Utility Price

The GMES Natural Gas Market Model produces detailed estimates of the quantities consumed and prices paid by residential, industrial, commercial, and electric utility users. The residential price is represented in the Wharton model, but there are no separate variables for the other three gas users. To reflect changes in gas costs to industrial, commercial, and electric utility users, the Wharton gas utility price index was altered to match the change in the weighted average of prices paid by industrial, commercial, and electric utility users estimated by GMES. The three series were first averaged using the gas consumption of each user as weights. Table A-4 lists the GMES prices in 1980 dollars. Tables A-5 through A-7 list the consumption of gas, the weights used, and the weighted average prices.

The prices in Table A-7 were used to create a current dollar series in the same manner as the wellhead price current dollar series was created. The final current dollar series is listed in Table A-8.

The corresponding price index in Wharton is the gross output price for gas utilities (PXGGRGU492). PXGGRGU492 is a current dollar price index with 1972 = 100.0. The 1980 value is 406.86. The new price indexes for input to WAIFM, were created by starting with the base value of 2.806 in 1980 and increasing the index each year by the proportional changes in the series in Table A-8. The new series and the control values are listed in Table A-9.

3. Residential Price of Natural Gas

The GMES model produces estimates of the price paid by residential users of natural gas in 1980 dollars per thousand cubic feet. GMES estimates for the two scenarios are shown in Table A-10.

The 1980 dollar values were converted to current dollar values using the GNP deflator. The current dollar series are given in Table A-11.

The residential price series in Wharton is an index with 1972 = 100.0 and 1980 = 297.73. To calculate the new values of the residential price of natural gas (PDCESSUG), for each year, the 1980 base value of 297.73 was increased by the proportional change in the values listed in Table A-11 over the 1980 value. The new series is shown in Table A-12.

TABLE A-4

RETAIL PRICES - GMES
(1980 Dollars/Mcf)

	REFCUR85		
Year	Industrial	Commercial	Electric Utility
1980	2.71	3.44	2.49
1981	2.97	3.74	2.70
1982	3.15	3.98	2.84
1983	3.33	4.24	3.00
1984	3.50	4.48	3.10
1985	5.60	6.29	5.52
1986	5.68	6.40	5.61
1987	5.77	6.43	5.74
1988	5.96	6.63	5.93
1989	6.16	6.84	6.14
1990	6.37	7.07	6.36

	REFFUL85		
Year	Industrial	Commercial	Electric Utility
1980	2.71	3.44	2.49
1981	2.97	3.74	2.70
1982	5.02	5.81	4.82
1983	5.11	5.90	4.93
1984	5.27	6.07	5.11
1985	5.47	6.30	5.34
1986	5.62	6.45	5.50
1987	5.75	6.58	5.65
1988	5.91	6.74	5.83
1989	6.12	6.97	6.07
1990	6.33	7.19	6.31

TABLE A-5

INDUSTRIAL, COMMERCIAL, AND ELECTRIC UTILITY CONSUMPTION - GMES
(Tcf/Year)

	REFCUR85		
Year	Industrial	Commercial	Electric Utility
1980	6.6433	2.7661	3.5281
1981	6.4200	2.7766	3.2431
1982	6.3258	2.8009	2.9550
1983	6.2862	2.8242	2.7548
1984	6.1826	2.8521	2.4347
1985	6.3248	2.7669	2.7894
1986	6.6691	2.7703	2.7646
1987	6.9906	2.7809	2.8483
1988	7.0584	2.7763	2.7896
1989	7.0685	2.7224	2.7715
1990	7.0353	2.7664	2.6339

	REFFUL85		
Year	Industrial	Commercial	Electric Utility
1980	6.6433	2.7661	3.5281
1981	6.4200	2.7766	3.2431
1982	6.8302	2.5857	3.2868
1983	6.8911	2.6329	3.1376
1984	6.7582	2.6733	2.9664
1985	6.5133	2.7666	2.7608
1986	6.6261	2.7661	2.7099
1987	6.8246	2.7681	2.6858
1988	6.9677	2.7670	2.6286
1989	6.9086	2.7614	2.5352
1990	6.8418	2.7565	2.4392

Year	Total REFCUR85	Total REFFUL82
1980	12.938	-
1981	12.440	12.440
1982	12.082	12.703
1983	11.865	12.662
1984	11.469	12.398
1985	11.881	12.041
1986	12.204	12.102
1987	12.620	12.278
1988	12.624	12.363
1989	12.562	12.205
1990	12.438	12.038

TABLE A-6

CONSUMPTION WEIGHTS

	REFCUR85		
Year	Industrial	Commercial	Electric Utility
1980	.513	.214	.273
1981	.516	.223	.261
1982	.524	.232	.245
1983	.530	.238	.232
1984	.539	.249	.212
1985	.532	.233	.235
1986	.546	.277	.227
1987	.554	.220	.226
1988	.559	.220	.221
1989	.563	.221	.217
1990	.566	.222	.212

	REFFUL85		
Year	Industrial	Commercial	Electric Utility
1980	.513	.214	.273
1981	.516	.223	.261
1982	.538	.204	.259
1983	.544	.208	.248
1984	.545	.216	.239
1985	.541	.230	.229
1986	.548	.229	.224
1987	.556	.225	.219
1988	.564	.224	.213
1989	.566	.226	.208
1990	.568	.229	.203

TABLE A-7

INDUSTRIAL, COMMERCIAL, AND ELECTRIC UTILITY PRICE
(1980 Dollars/Mcf)

Year	REFCUR85	REFFUL82
1980	2.806	2.806
1981	3.072	3.072
1982	3.267	5.129
1983	3.470	5.230
1984	3.659	5.404
1985	5.742	5.631
1986	5.828	5.783
1987	5.909	5.915
1988	6.101	6.079
1989	6.306	6.302
1990	6.524	6.523

TABLE A-8

INDUSTRIAL, COMMERCIAL, AND ELECTRIC UTILITY PRICE - GMES
(Current Dollars/Mcf)

Year	REFCUR85	REFFUL82
1980	2.806	2.806
1981	3.348	3.348
1982	3.853	6.195
1983	4.409	6.834
1984	5.014	7.639
1985	8.621	8.565
1986	9.397	9.400
1987	10.204	10.262
1988	11.262	11.271
1989	12.452	12.473
1990	13.773	13.808

TABLE A-9

PXGGRGU492 - GROSS OUTPUT PRICE - GAS UTILITIES - WAIFM
(1972 = 100)

Year	CNTL1081	REFCUR85	REFFUL82
1980	406.8	-	-
1981	469.7	485.4	485.4
1982	545.8	558.6	898.1
1983	624.7	639.1	990.6
1984	710.5	726.5	1,106.9
1985	897.6	1,248.6	1,241.1
1986	1,171.8	1,360.7	1,362.0
1987	1,550.8	1,477.4	1,487.1
1988	1,785.6	1,630.7	1,633.4
1989	2,045.3	1,803.7	1,807.8
1990	2,340.6	1,995.0	2,001.5

TABLE A-10

RESIDENTIAL PRICE OF NATURAL GAS - GMES
(1980 Dollars/Mcf)

Year	REFCUR85	REFFUL82
1980	3.76	-
1981	4.06	-
1982	4.31	6.13
1983	4.58	6.22
1984	4.83	6.39
1985	6.59	6.62
1986	6.70	6.77
1987	6.72	6.90
1988	6.93	7.06
1989	7.14	7.29
1990	7.36	7.51

TABLE A-11

RESIDENTIAL PRICE OF NATURAL GAS
(Current Dollars/Mcf)

Year	REFCUR85	REFFUL82
1980	3.760	3.760
1981	4.426	4.426
1982	5.083	7.404
1983	5.817	8.129
1984	6.615	9.032
1985	9.883	10.069
1986	10.790	11.004
1987	11.588	11.971
1988	12.775	13.090
1989	14.083	14.429
1990	15.521	15.898

TABLE A-12

PDCESSUG - RESIDENTIAL PRICE OF NATURAL GAS - WAIFM
(1972 = 100.0)

Year	CNTL1081	REFCUR85	REFFUL82
1981	350.7	350.4	-
1982	410.9	402.5	586.2
1983	473.7	460.6	643.4
1984	530.6	523.8	714.8
1985	663.9	782.6	796.8
1986	860.8	854.4	870.8
1987	1,133.8	917.6	947.3
1988	1,296.7	1,011.6	1,036.0
1989	1,476.7	1,115.1	1,142.1
1990	1,682.8	1,229.2	1,258.4

4. Import Price of Natural Gas

The GMES model produces estimates of the total cost of imported gas and the total quantity of imported gas. An import price in 1980 dollars is calculated by dividing the cost by the quantity of imported gas. The constant dollar prices are listed in Table A-13. Current dollar prices are calculated using the estimated GNP deflator. The current dollar series that were input to the Wharton model are listed in Table A-14.

The appropriate Wharton index is the unit price of natural gas imports (PUTMCGT34). As was the case with the wellhead price, Wharton and GMES estimates for 1980 differ in point of measurement and treatment of taxes. New Wharton estimates for PUTMCGT34 were created by multiplying the GMES estimates in Table A-14 by 518.6/4.56. The new values are listed in Table A-15.

5. Residential Consumption of Natural Gas

Estimates of residential consumption of natural gas are produced by the GMES model in Tcf/year. The estimates are listed in Table A-16.

The quantities in Table A-16 were converted to a quantity index with 1980 = 1.0 and multiplied by the 1980 WAIFM value of real personal consumption expenditures on natural gas (CESSUG). CESSUG is measured in 1972 dollars. The 1980 value is equal to 6.38 billion 1972 dollars. The series in Table A-16 was converted to scalers with 1980 equal to one and multiplied by 6.38 to create the series in Table A-17.

The values in Table A-17 are target values of CESSUG. CESSUG is an identity and can be adjusted only by adjusting the other parts of the identity.

The equation for the personal consumption of natural gas (CESSUG) is:

CESSUG = RACESSUG/UG+H * (CETHU-W - CESSUE)

where: RACESSUG/UG+H = ratio of personal consumption expenditures on gas to gas plus fuel oil - behavioral;

CETHU-W = personal consumption on household utilities - excluding water;

CESSUE = personal consumption expenditures on electricity.

TABLE A-13

IMPORT PRICE OF NATURAL GAS - GMES
(1980 Dollars/Mcf)

Year	REFCUR85	REFFUL82
1980	4.56	4.56
1981	4.48	4.48
1982	4.47	4.20
1983	4.60	4.28
1984	4.74	4.44
1985	6.76	4.66
1986	6.47	4.79
1987	5.89	4.91
1988	5.96	5.07
1989	6.07	5.28
1990	6.21	5.49

TABLE A-14

IMPORT PRICE OF NATURAL GAS - GMES
(Current Dollars/Mcf)

Year	REFCUR85	REFFUL82
1981	4.88	4.88
1982	5.27	5.07
1983	5.85	5.59
1984	6.50	6.26
1985	10.15	7.08
1986	10.43	7.78
1987	10.17	8.51
1988	11.00	9.40
1989	11.99	10.45
1990	13.11	11.62

TABLE A-15

PUTMCGT34 - IMPORT PRICE OF NATURAL GAS - WAIFM
(Current Cents/Mcf)

Year	CNTL1081	REFCUR85	REFFUL82
1981	537.0	555.4	555.4
1982	593.0	599.7	576.6
1983	658.7	664.8	635.3
1984	734.5	738.8	712.4
1985	807.9	1,154.4	804.7
1986	888.7	1,186.6	884.3
1987	977.6	1,156.9	968.0
1988	1,075.4	1,251.3	1,068.5
1989	1,182.9	1,363.2	1,188.1
1990	1,301.2	1,491.1	1,321.4

TABLE A-16

RESIDENTIAL CONSUMPTION OF NATURAL GAS - GMES
(Tcf/Year)

Year	REFCUR85	REFFUL82
1980	4.951	-
1981	4.945	-
1982	4.965	4.545
1983	4.981	4.612
1984	5.007	4.666
1985	4.924	4.918
1986	4.931	4.919
1987	4.956	4.924
1988	4.948	4.924
1989	4.940	4.915
1990	4.931	4.907

TABLE A-17

TARGET VALUES OF RESIDENTIAL CONSUMPTION OF NATURAL GAS - WAIFM
(Billions of 1972 Dollars)

Year	CNTL1081	REFCUR85	REFFUL82
1981	6.5	6.4	6.4
1982	6.4	6.4	5.9
1983	6.6	6.4	6.0
1984	6.7	6.4	6.0
1985	6.7	6.3	6.3
1986	6.5	6.4	6.3
1987	6.4	6.4	6.3
1988	6.3	6.4	6.3
1989	6.2	6.4	6.3
1990	6.1	6.4	6.3

Each of the right-hand side variables in the equation will change during a simulation. RACESSUG/UG+H is a function of the price of gas, wages, and the housing capital stock that is heated by gas. CETHU-W is a function of the relative price of utilities (excluding water) and personal disposable income per household. CESSUE is an identity which is equal to the ratio of personal consumption of electricity to total personal consumption of energy times CETHU-W. The first runs were done with no adjustment to this equation. The response in CESSUG was not as price sensitive as was expected and, as a result, personal consumption of gas was higher than the GMES's estimates. To match the GMES estimates, RACESSUG/UG+H was exogenized and set to a value that would make CESSUG equal the GMES estimates. The formula used was:

RACESSUG/UG+H = CESSUG/(CETHU-W - CESSUE)

When these new values are input to the simulation, CETHU-W and CESSUE change. A new iteration was required to further adjust the value of CESSUG.

The final values for RACESSUG/UG+H are listed in Table A-18. The final values for CESSUG are listed in Table A-19.

TABLE A-18

RACESSUG/UG+H RATIO, PERSONAL CONSUMPTION ON GAS TO GAS PLUS HEATING OIL - WAIFM
(Percentage)

Year	CNTL1081	REFCUR85	REFFUL82
1981	65.1	64.0	-
1982	63.3	63.4	59.1
1983	66.3	63.8	61.7
1984	66.0	63.0	63.0
1985	66.0	62.8	68.6
1986	66.0	64.1	70.6
1987	66.0	65.2	70.9
1988	66.0	65.3	69.5
1989	66.0	64.7	67.1
1990	65.9	63.6	64.5

TABLE A-19

CESSUG - PERSONAL CONSUMPTION OF NATURAL GAS - WAIFM
(Billion 1972 Dollars)

Year	REFCUR85	REFFUL82
1981	6.4	-
1982	6.4	5.9
1983	6.4	6.0
1984	6.5	6.0
1985	6.3	6.4
1986	6.3	6.3
1987	6.4	6.3
1988	6.4	6.3
1989	6.4	6.3
1990	6.4	6.3

6. Electric Utility Use of Natural Gas

The GMES model produces estimates of the consumption of natural gas by electric utilities in trillion cubic feet. These estimates and the Wharton control forecast of the value of electric utility consumption of natural gas are listed in Table A-20.

TABLE A-20

ELECTRIC UTILITY USE OF NATURAL GAS
(Trillion Cubic Feet/Year)

Year	CNTL1081 WAIFM	REFCUR85 GMES	REFFUL82 GMES
1980	3.682	3.528	3.528
1981	3.605	3.243	3.243
1982	3.493	2.955	3.287
1983	3.363	2.755	3.138
1984	3.290	2.435	2.966
1985	3.184	2.789	2.761
1986	3.049	2.765	2.710
1987	2.901	2.848	2.686
1988	2.767	2.790	2.629
1989	2.625	2.722	2.535
1990	2.488	2.634	2.439

The corresponding WAIFM variable is Purchases of Natural Gas by Electric Utilities (XMQFUT491NG). XMQFUT491NG is an identity.

XMQFUT491NG = XQKUT491NG * RAFKUT491NG

where: XQKUT491NG = production of electricity by natural gas - billion kwh;

RAFKUT491NG = ratio, natural gas inputs to production of electricity by natural gas in electric plants - Tcf/kwh - EXOGENOUS;

XMQFUT491NG = purchases of natural gas by electric utilities - Tcf/year.

XQKUT491NG is also an identity.

$$\text{XQKUT491NG} = \text{XQKUT491NG+TP} * \text{RANGNG+TPUT491}$$

where: XQKUT491NG+TP = production of electricity by natural gas petroleum - billion kwh-identity;

RANGNG+TPUT491 = ratio, production of electricity by natural gas to natural gas plus petroleum.

The production of electricity by natural gas and petroleum is derived from a series of identities and exogenous ratios. Demand for electricity is first derived using the I-O matrix, given the level of final demand. The demand for electricity is satisfied by the different sources of electricity production according to exogenous ratios. The ratio that must be adjusted to equate value of XMQFUT491NG - Purchases of Natural Gas by Electric Utilities--to the GMES value is RANGNG+TPUT491. This ratio is adjusted, because in the short-run utilities are able to substitute only between oil and gas. The formula that is used to calculate RANGNG+TPUT491 is:

$$\text{RANGNG+TPUT491} = \frac{\text{XMQFUT491NG}}{\text{XQKUT491NG+TP} * \text{RAFKUT491NG}}$$

RAFKUT491NG is exogenous. XMQFUT491NG is set at GMES values which have been calculated by multiplying the GMES values in Table A-20 by 3.682/3.528. XQKUT491NG+TP is taken from the first set of simulations. The final values of RANGNG+TPUT491 are listed in Table A-21. The final values of electric utility use of natural gas are given in Table A-22. The values of XMQFUT491NG do not exactly match the GMES target values, but they do not differ enough to justify an additional iteration.

7. Domestic Production of Natural Gas

Estimates of natural gas production are produced by the GMES and listed in Table A-23.

The WAIFM value of production of natural gas - XQFMG131N for 1980 equals 19.348 Tcf. The GMES values of Table A-23 were multiplied by 19.348/19.4701 to form the inputs to WAIFM listed in Table A-24.

8. Imports of Natural Gas

The GMES model produces estimates of natural gas imports in trillion cubic feet per year. These estimates are listed in Table A-25.

The proportional changes in the GMES import values listed in Table A-25 were used to increase the 1980 Wharton value of .994 Tcf/year. The target values of imports are listed in Table A-26.

TABLE A-21

RANGNG+TPUT491 RATIO, PRODUCTION OF ELECTRICITY BY NATURAL GAS TO NATURAL GAS PLUS PETROLEUM
(Ratio)

Year	CNTL1081	REFCUR85	REFFUL82
1981	.5250	.4929	.4929
1982	.5050	.4455	.4997
1983	.5000	.4266	.4931
1984	.4950	.3809	.4737
1985	.4900	.4489	.4512
1986	.4850	.4569	.4556
1987	.4800	.4883	.4641
1988	.4750	.4958	.4683
1989	.4700	.5024	.4673
1990	.4650	.5045	.4675

TABLE A-22

XMQFUT491NG - ELECTRIC UTILITY USE OF NATURAL GAS
(Tcf/Year)

Year	CNTL1081	REFCUR85	REFFUL82
1981	3.605	3.384	-
1982	3.493	3.083	3.441
1983	3.363	2.872	3.295
1984	3.290	2.537	3.126
1985	3.184	2.901	2.900
1986	3.049	2.873	2.843
1987	2.901	2.960	2.809
1988	2.767	2.901	2.743
1989	2.625	2.833	2.641
1990	2.488	2.743	2.541

TABLE A-23

DOMESTIC PRODUCTION OF NATURAL GAS - GMES
XQFMG131N
(Tcf/Year)

Year	REFCUR85	REFFUL82
1980	19.4701	19.4701
1981	18.8471	18.8471
1982	18.4382	18.4187
1983	17.8736	17.9125
1984	16.9390	17.6204
1985	17.3089	17.3284
1986	17.4257	17.2894
1987	17.8930	17.4452
1988	17.8930	17.9904
1989	17.7957	17.3479
1990	17.6594	17.1532

TABLE A-24

DOMESTIC PRODUCTION OF NATURAL GAS - WAIFM
XQFMG131N
(Tcf/Year)

Year	CNTL1081	REFCUR85	REFFUL82
1981	19.148	18.733	-
1982	18.957	18.318	18.311
1983	18.748	17.758	17.795
1984	18.542	16.826	17.501
1985	18.338	17.208	17.216
1986	18.136	17.322	17.181
1987	19.937	17.778	17.331
1988	17.739	17.772	17.876
1989	17.544	17.692	17.238
1990	17.351	17.539	17.037

TABLE A-25

IMPORTS OF NATURAL GAS - GMES
(Tcf/year)

Year	REFCUR85	REFFUL82
1980	.952	.952
1981	.966	.966
1982	1.252	1.252
1983	1.257	1.757
1984	1.807	1.807
1985	1.962	1.962
1986	2.044	2.044
1987	2.044	2.044
1988	2.044	2.044
1989	2.044	2.044
1990	2.044	2.044

TABLE A-26

TARGET VALUES - IMPORTS OF NATURAL GAS
(Tcf/Year)

Year	REFCUR85	REFFUL82
1980	.994	.994
1981	1.009	1.009
1982	1.307	1.307
1983	1.835	1.835
1984	1.887	1.887
1985	2.049	2.049
1986	2.134	2.134
1987	2.134	2.134
1988	2.134	2.134
1989	2.134	2.134
1990	2.134	2.134

Gas imports cannot be adjusted directly in the Wharton model, because that variable is an identity. The imports of natural gas are determined so as to maintain equality between the domestic requirements of natural gas and the sum of domestic production and imports. Such a treatment recognizes that the domestic production of natural gas is constrained by the availability of natural resources. This production constraint is introduced into the input-output sector of the model by specifying the domestic production of natural gas exogenously and solving the gas imports as the residual between domestic requirements and domestic production. The introduction of this constraint into the input-output sector of the model enables the solution of the input-output system to be partitioned into two independent blocks. In the first block, the unconstrained production levels for sectors one through (n-1) are determined. These production levels then enable the determination of the domestic requirements of natural gas. In the second block, the domestic production of natural gas is subtracted from domestic requirements in order to determine the necessary level of gas imports. This approach assumes an infinitely elastic import supply function.

$$\mathrm{TMCGT34} = [\sum_{j=1}^{n-1} a_{nj} X_j + (a_{nn} * \mathrm{XGIOMG131N}) + FD_n) - \mathrm{XGIOMG131N}$$

where TMCGT34 = imports, natural gas (billion 1972 dollars)

a_{nj} = constant dollar requirements of natural gas per unit of output in the jth producing sector,

X_j = gross output of the jth producing sector,

a_{nn} = constant dollar requirements of natural gas per unit of crude petroleum output,

XGIOMG131N = domestic production (gross output) of natural gas in billions of 1972 dollars, and

FD_n = deliveries of natural gas to all final expenditure categories except imports.

(Source: Wharton EFA Annual and Industry Forecasting Model documentation.)

TMCGT34 is measured in constant dollars. The Wharton variable expressing gas imports in trillion cubic feet per year is TMQTGT34:

$$\mathrm{TMQTGT34} = (\mathrm{TMCGT34} * 100.)/\mathrm{PUTMCGT34}(1972)$$

where: TMQTGT34 = imports of natural gas - trillion cubic feet per year;

PUTMCGT34 = unit price of natural gas imports, 1972 cents per thousand cubic feet.

TMQTGT34 is an identity that can be adjusted. The values of TMQTGT34 from the control solution were reduced to match the GMES values. This process is an iterative one. Changes in TMQTGT34 feed into the model, which cause changes in the demand for natural gas. Since the production of natural gas is fixed, the imports of natural gas, TMCGT34 and TMQTGT34, change further and additional adjustments are required. The final values of TMQTGT34 are listed in Table A-27.

9. Petroleum Imports

The GMES model produces estimates of the amount of oil consumed by oil and gas consumers. The difference between the REFCUR85 and REFFUL82 scenarios is used to adjust the REFFUL82 Wharton simulation of the value of oil imports. Table A-28 lists the values and differences input to the WAIFM variable for U.S. Crude Petroleum imports, million barrels per day (TMQBPDGT333).

10. Price of Imported Crude Oil

The GMES model uses one real imported crude oil price for all simulations. This price is converted from 1980 dollars to current dollars using the GNP deflators from the different runs. As the deflators are different for each scenario, the current dollar series are different. Prices are given in Table A-29.

11. Price of Imported Residual Fuel Oil

The GMES model uses one real price of imported residual fuel oil for all scenarios. These prices are converted to nominal values by using the GNP deflator. GMES values are in 1980 dollars per thousand cubic feet equivalent. They were converted to current dollars per barrel by multiplying by the change in the GNP deflator and dividing by .1622 Mcf equivalent per barrel. The prices are listed in Table A-30.

TABLE A-27

TMQTGT34 - IMPORTS OF NATURAL GAS - WAIFM
(Tcf/Year)

Year	CNTL1081	REFCUR85	REFFUL82
1981	.989	1.008	1.008
1982	1.600	1.305	1.308
1983	1.901	1.837	1.835
1984	2.372	1.898	1.888
1985	2.657	2.072	2.050
1986	2.681	2.175	2.138
1987	2.739	2.190	2.139
1988	2.868	2.199	2.142
1989	3.028	2.200	2.143
1990	3.222	2.197	2.143

TABLE A-28

OIL EXPENSE - GMES
(Million Barrels Per Day)

Year	REFCUR85 GMES	REFFUL82 GMES	TMQBPDGT333+ (REFFUL82-REFCUR85)
1981	1.6831	1.6831	0.
1982	1.7191	1.3176	- .4015
1983	1.6979	1.2237	- .4742
1984	1.7818	1.2501	- .5317
1985	1.4412	1.3644	- .0768
1986	1.3995	1.4464	.0469
1987	1.3305	1.4882	.1577
1988	1.4730	1.5939	.1208
1989	1.6335	1.8001	.1666
1990	1.8089	1.9953	.1864

TABLE A-29

PRICE OF IMPORTED CRUDE OIL - PUTMCGT333

Year	GMES 1980 $/BBL	WAIFM REFCUR85 Cu $/BBL	WAIFM REFFUL82 Cu $/BBL
1981	34.000	34.004	34.004
1982	32.730	36.266	36.266
1983	33.710	40.407	40.407
1984	34.720	45.004	45.004
1985	35.760	49.877	49.877
1986	36.840	54.911	54.911
1987	37.940	60.361	60.361
1988	39.080	66.453	66.453
1989	40.250	73.067	73.067
1990	41.460	80.505	80.505

TABLE A-30

PRICE OF IMPORTED RESIDUAL FUEL OIL - PUTMCGT3344

Year	GMES 1980 $/Mcf Equivalent	WAIFM REFCUR85 Cu $/BBL	WAIFM REFFUL82 Cu $/BBL
1981	5.28	27.909	27.909
1982	5.08	29.052	29.750
1983	5.24	32.277	33.197
1984	5.39	35.795	36.925
1985	5.55	40.364	40.913
1986	5.72	44.671	45.060
1987	5.89	49.258	49.526
1988	6.07	54.267	54.552
1989	6.25	59.780	59.965
1990	6.44	65.872	66.091

12. Price of Imported Distillate Fuel Oil

The GMES model uses one real price of imported distillate fuel oil for all scenarios. The corresponding WAIFM variable is the price of other refined petroleum products - PUTMCGT3OT. Other refined products include distillate fuel oil, gasoline, lubricants, etc. To calculate the changes in PUTMCGT34, the non-distillate products, such as gasoline, were assumed to change in price by the same percentage as the change in distillate prices. The GMES values were expressed in 1980 dollars per thousand cubic feet equivalent. The GMES values were converted to current dollars per barrel by multiplying by the change in the GNP deflator and dividing by .1751 Mcf equivalent per barrel. Table A-31 lists the final prices.

13. Investment in Oil and Gas Mining

Investment in oil and gas mining in WAIFM does not respond to rapid gas price increases as it does in the GMES supply model. Increased investment is required to produce more natural gas. WAIFM, however, does not forecast these increases. To compensate for this deficiency, the investment in the oil and gas mining sector was increased by the required amount. The 1980 dollar increases are:

ΔINVESTMENT MINING (Billion 1980 $)	1982	1983	1984	1985	1986
	4.95	9.62	15.05	8.17	3.88
	1987	1988	1989	1990	
	1.23	-.55	-2.03	-3.29	

TABLE A-31

PRICE OF IMPORTED DISTILLATE FUEL OIL - PUTMCGT3OT

Year	GMES 1980 $/Mcf Equivalent	WAIFM REFCUR85 Current $/BBL	WAIFM REFFUL82 Current $/BBL
1981	6.80	65.32	65.32
1982	6.56	68.18	69.82
1983	6.74	75.45	77.60
1984	6.93	83.64	86.28
1985	7.13	94.24	95.52
1986	7.33	103.03	104.94
1987	7.53	114.45	115.07
1988	7.75	125.92	126.58
1989	7.97	138.54	138.97
1990	8.19	152.25	152.75

The 1980 dollar series was converted to 1972 dollars by dividing by the 1980 value of the investment deflator PDIBFN = 1.868.

ΔIAMG (Billion 1972 $)	1982	1983	1984	1985	1986	1987	1988	1989	1990
	2.650	5.150	8.057	4.374	2.077	.659	-.294	-1.081	-1.761

These changes were added to the accelerated full decontrol case only.

14. Inventories, Housing Starts, and Conceptual Difference Adjustments

Initial simulations with WAIFM produced severe downturns in economic activity in 1986 and 1990 which were considered implausible in the context of accelerated natural gas decontrol. Minor adjustments were made in 1986, 1989, and 1990 to correct these changes. The conceptual difference between BEA and NIA investment values was increased in 1986 to offset a large decline which was inconsistent with changes in other years. Non-manufacturing business inventories and housing starts were increased in 1990 and the conceptual difference - residential investment versus value put in place - was increased in 1989 and 1990. These changes in WAIFM notation were:

ADDITIONAL ADD-FACTORS REFFUL82

Conceptual difference - residential investment versus value put in place

```
INCR IBFRNXNU-MH      .121   .522   1989   1990
```

Conceptual difference - BEA versus NIA investment

```
INCR IBA             1.271   1986
```

Housing starts - mobile homes

```
INCR HSPRMH           .007   1990
```

Housing starts - multi-family

```
INCR HSPRSM           .008   1990
```

Housing starts - single family

```
INCR HSPRS1           .025   1990
```

Inventories - non-manufacturing

```
INCR IBINNM           .674   1990
```

II. STANDARD CASE INPUTS

Three simulations were run that required changing Wharton's direct input-output coefficients. The coefficients were changed for three reasons. First, the behavioral equations that were used to forecast the coefficients were estimated over a period of natural gas curtailments. There is little reason to expect that these estimated equations would forecast well after the end of curtailments. Second, the estimates of energy use by sector in Wharton are based on Commerce Department input-output data which are several years old. An examination of the Wharton estimates of fuel use for 1978 reveals significant discrepancies between Wharton estimates and data from the 1978 Survey of Manufacturers. Third, for the above reasons, the estimates of industrial gas use from the naive case are much lower than GMES estimates of industrial gas use.

A. REFFUL82 - Standard Case

1. Input-Output Coefficient Adjustment

The first step in the adjustment process was to rerun the REFFUL82 solution and write the input-output coefficients to a direct access file. The 52 WAIFM sectors that were used in these simulations are listed below in Table A-32. The industrial sectors adjusted were 1-6 and 10-35 and commercial sectors adjusted were 7-9 and 36-52.

The Wharton model does not record fuel use by sector or sectoral gross outputs. To calculate fuel use, the input-output coefficients, ratios of energy to value-added, ratios of materials to value-added, and value-added by sector must be retrieved from the solution file. Gross output to value-added ratios are calculated as one plus energy to value-added plus materials to value-added ratios. Gross output by sector is calculated by multiplying value added by sector by the ratio of gross output to value-added by sector. Equations (1) and (2) describe the calculations using WAIFM terminology.

TABLE A-32

INDUSTRIAL AND COMMERCIAL SECTORS USED TO ADJUST GAS USE

Variable Ending	Sector No.	Title	SIC Code
AG	1.	Agriculture, Forestry & Fisheries	01,02,07-09
MG10	2.	Metal Mining	10
MG11+12	3.	Coal Mining	11 + 12
MG13-N	4.	Crude Petroleum Mining	part of 13
MG131N	5.	Natural Gas Mining	part of 13
MG14	6.	Mining & Quarrying of Nonmetalic Minerals	14
CCR	7.	Residential Contract Construction	part of 15-17
CCN	8.	Nonresidential Contract Construction	part of 15-17
CCO	9.	Other Contract Construction	part of 15-17
MFN20	10.	Food & Kindred Products	20
MFN21	11.	Tobacco Manufactures	21
MFN22	12.	Textile Mill Products	22
MFN23	13.	Apparel and Related Products	23
MFN26	14.	Paper and Allied Products	26
MFN27	15.	Printing and Publishing	27
MFN281+6	16.	Organic & Inorganic Chemicals	281, 286,
MFN28OT	17.	Other Chemicals	282-85, 287, 289
MFN29	18.	Petroleum and Related Industries	29
MFN30	19.	Rubber and Miscellaneous Plastic Products	30
MFN31	20.	Leather and Leather Products	31
MFD24	21.	Lumber and Wood Products	24
MFD25	22.	Furniture and Fixtures	25
MFD324	23.	Cement	324
MFD32-324	24.	Other Stone, Clay, and Glass	32 except 324
MFD331+2	25.	Iron and Steel	331, 332
MFD3334	26.	Aluminum	3334
MFD33OT	27.	Other nonferrous Metals	33 except 331, 332, 3334
MFD34	28.	Fabricated Metal Products	34
MFD35	29.	Machinery, Except Electricity	35
MFD36	30.	Electrical Machinery	36
MFD372	31.	Aircraft	372
MFD373.9	32.	Other Transportation Equipment	37 except 371, 372
MFD371	33.	Automobiles	371

TABLE A-32

INDUSTRIAL AND COMMERCIAL SECTORS USED TO ADJUST GAS USE

Variable Ending SIC Code	Sector No.	Title	
MFD38	34.	Instruments & Related Products	38
MFD39	35.	Miscellaneous Manufacturing	39
RGT40	36.	Railroad Transportation	40
RGT41	37.	Local and Highway Passenger Transportation	41
RGT42	38.	Motor Freight Transportation and Warehousing	42
RGT44	39.	Water Transportation	44
RGT45	40.	Air Transportation	45
RGT46	41.	Pipeline Transportation	46
RGT47	42.	Transportation Services	47
RGC48	43.	Communications	48
UT491	44.	Electric Utilities (Public & Private)	491
RGU492	45.	Gas Utilities	492
RGU494.9	46.	Sanitary Services	494-499
WR	47.	Wholesale-Retail Trade	50-59
FI	48.	Finance, Insurance and Real Estate	60-67
SV-80	49.	Nonmedical Services	70-89 excluding 80
SV80	50.	Medical Services	80
GVFE-491	51.	Other Federal Enterprises	
GVSE-491	52.	Other State and Local Enterprises	

Gross output to value-added:

$$RAXMN{+}P\& = RAXMN\& + RAXMP\& + 1 \qquad (1)$$

where:

RAXMN+P& = Ratio of gross output to value-added (1972 dollars)

RAXMN& = Ratio of material inputs to value-added (1972 dollars)

RAXMP& = Ratio of energy inputs to value-added (1972 dollars)

& = AG, ..., GVSE-491

Gross output:

$$XGG\& = XVG\& * RAXMN{+}P\& \qquad (2)$$

where:

XGG& = Gross output (1972 dollars)

XVG& = Value-added (1972 dollars)

& = AG, ..., GVSE-491

Gross outputs for coal mining, crude petroleum mining, natural gas mining, petroleum refining, electric utilities, and gas utilities are recorded by WAIFM, so they need not be calculated.

Materials used by sector in 1972 dollars is calculated by multiplying the gross outputs by the input-output coefficients.

$$XMP\&J = AJ\& * XGG\& \qquad (3)$$

where:

XMP&J = Material J use by sector &

AJ& = Input-output coefficient, proportion of total inputs of sector & that come from J

Thus, for example,

XMPMFN20G = Total gas use by food and kindred products (1972 dollars)

The 1972 dollar series were then divided by their 1972 price to get the quantities consumed by each sector.[1]

1972 Price of Refined Petroleum
Paid by Industrial and Commercial Users = $6.56/bbl

1972 Price of Natural Gas Paid
by Industrial and Commercial Users = $ .75/Mcf

The quantities in barrels and cubic feet were then converted to Btus using the following ratios:

1,000 Barrels = 6164.2 MMBtu
1 Mcf = 1.024 MMBtu

(Source: Survey of Manufacturers 1976)

A primary reason that the input-output coefficients were adjusted was to take account of possible efficiency gains that would occur with the end of natural gas price controls and curtailments. WAIFM estimates of fuel use are based on behavioral equations which were estimated over a sample period that exhibited both low prices and curtailments. The behavioral equations were estimated over the 1960-1977 sample period. The industrial gas prices and quantities during 1960-1977 are shown in Table A-33.

Given this time series of observations, there is little reason to expect the industrial demand for gas to be accurately specified. Because the real price of gas was falling and the quantity consumed rising in 1960-1970, and vice versa in 1971-1977, a negative elasticity of demand would have been estimated, but this would not necessarily reflect the true elasticity of demand for gas.

The second major justification for changing the I-O coefficients was a data problem. The Wharton model uses a 1967 Commerce Department Input-Output table as its base table. This table is updated yearly with National Income Accounts data and industrial data from sources such as the American Gas Association. The

---

[1] Prices were provided by Mark French of WEFA.

TABLE A-33

INDUSTRIAL GAS MARKET

Year	Real Price (1972 $/MMBtu)	Quantity (Quads)	WAIFM GNP Deflator (1972 = 100.0)
1960	.48	4.709	68.7
1961	.51	4.786	69.3
1962	.50	5.100	70.6
1963	.49	5.438	71.7
1964	.48	5.912	72.8
1965	.47	6.147	74.4
1966	.46	6.653	76.8
1967	.44	7.014	79.1
1968	.42	7.595	82.5
1969	.41	8.136	86.8
1970	.41	8.439	91.4
1971	.43	8.646	96.0
1972	.45	8.776	100.0
1973	.47	8.371	105.8
1974	.57	8.153	116.0
1975	.78	6.837	127.1
1976	.99	7.107	133.7
1977	1.20	6.711	141.7

technique that is used alters the I-O coefficients so that the total estimated output (interindustry plus final sales) equals the published source total. Unfortunately, there is no assurance that the total industrial use of a commodity such as gas will equal the actual total in the sample period (1960-1977).

To check the accuracy of historical data on gas use by sector, a comparison of 1978 Wharton values with Commerce Department Survey of Manufacturers fuels data was made. The technique described earlier to calculate gas use was used for 1978. The estimates of gas use by SIC code are presented in Table A-34.

The discrepancy between Wharton's historical data and the actual data from the survey is 17 percent. The year 1978 was used, as it is the latest year that the I-O table was updated in the current version of the model. Apparently, not only is the estimation technique suspect, but the data used (the I-O coefficients) is also inaccurate.

TABLE A-34

GAS USE BY SECTOR 1978
(Bcf)

SIC	WAIFM	Survey of Manufacturers
20	458.9	416.5
26	291.1	359.6
28	824.4	1,423.8
29	628.1	856.4
30	74.4	72.8
32	637.6	539.3
33	818.0	987.1
34	238.9	194.1
35	191.4	139.6
Total	4,162.8	4,989.2

The final reason for Input-Output coefficient adjustment is that WAIFM forecasts of industrial and commercial gas use differ from GMES estimates. Industrial gas use in WAIFM and GMES is defined as Mining and Agriculture (SIC's 10-14, 01, 02, 07) and Manufacturing (SIC's 20-39). Commercial is defined as all other gas use except residential and electric utility. Table A-35 lists gas use forecasts by WAIFM.

Industrial and commercial gas use from GMES are listed in Table A-5 above. The reader will note that neither absolute levels nor relative differences between the current policy case (REFCUR85) and the accelerated decontrol case (REFFUL82) in WAIFM match the GMES estimates. Table A-36 lists the differences between the two policy cases as produced by WAIFM and GMES.

WAIFM forecasts declines in gas use with accelerated decontrol because the relative price of gas increases sharply in 1982. Decreases in gas use would be appropriate if the natural gas price increases were not due to a deregulation of the market. As Figure 1 in part 1 has noted, the price changes which accompany decontrol will coincide with increases in gas consumption if the controls were binding and the supply curve was positively sloped. The following section will briefly describe changes in gas consumption output and prices resulting from decontrol of gas prices.[1]

---

[1] For a more detailed description see: The Economic Efficiency Gains of Natural Gas Price Decontrol - A Micro-Macro Linked Approach, ICF, Inc., September 1981.

TABLE A-35

INDUSTRIAL AND COMMERCIAL GAS USE - WAIFM
(Bcf/year)

Year	Industrial REFCUR85	Industrial REFFUL82	Commercial REFCUR85	Commercial REFFUR82
1981	4,822.8	4,822.8	3,052.1	3,052.1
1982	4,919.4	4,747.0	3,077.4	2,851.2
1983	5,044.0	4,749.9	3,114.8	2,730.4
1984	5,194.4	4,805.1	3,170.0	2,689.6
1985	5,084.9	4,821.5	3,009.0	2,681.9
1986	5,087.1	4,845.6	2,928.6	2,732.8
1987	5,062.7	4,923.7	2,895.0	2,817.1
1988	5,071.0	5.003.5	2,912.2	2,901.5
1989	5,093.1	5,073.1	2,977.5	2,973.8
1990	5,150.0	5,140.3	3,069.2	3,056.0

TABLE A-36

DIFFERENCES IN GAS USE (REFFUL82-REFCUR85)
(Bcf/Year)

Year	Industrial WAIFM	Industrial GMES	Commercial WAIFM	Commercial GMES
1982	-172.4	504.3	-226.2	-215.2
1983	-294.1	604.8	-384.4	-191.3
1984	-389.3	575.6	-480.4	-178.9
1985	-263.4	188.5	-327.1	-0.3
1986	-241.5	-42.9	-195.8	-4.1
1987	-139.0	-165.9	-77.9	-12.8
1988	-67.5	-90.6	-10.7	-9.3
1989	-20.0	-159.8	-3.7	-10.1
1990	-9.7	-193.5	-13.2	-9.9

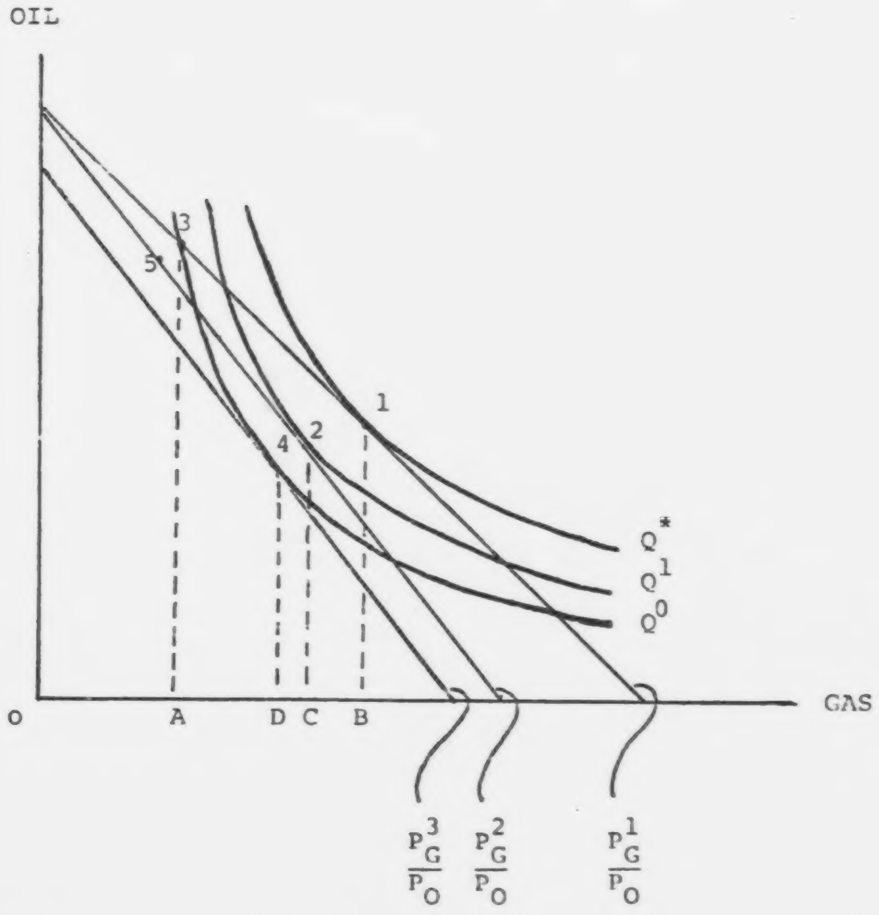
Figure A-1 shows the gas market under curtailments and price controls and after the removal of these restrictions. Under controls, the relative price of the two inputs is represented by P^1_G/P_o. P^1_G/P_o is the isocost line facing the firm. The optimum combination of gas and other input use would be point 1. However, curtailments restrict the amount of gas use to industry so firms must consume OA amount of gas and not the optimum amount OB. AB is the amount of gas curtailed to industry. The combination of gas and other inputs under price controls and curtailments that firms use is represented by point 3. Q^o is the level of output produced instead of the desired output Q^*, where Q^o is less than Q^*.

After decontrol of gas prices and the elimination of curtailments, the new isocost line is P^2_G/P_o. The line has rotated in because of the increase in gas prices. (Other prices are assumed to be constant, but they may also change with the increase in gas prices.) For the same energy costs, producers can produce more. Producers are now at point 2 on isoquant Q^1. The elimination of curtailments allow producers to switch oil for gas and be more efficient. At point 2, the ratio of the prices of inputs equals the ratio of the marginal products of the inputs.

Point 2 represents a possible outcome; output has risen, but costs have not. Another possible outcome is the same level of output, but lower costs. This combination is represented by point 4 in Figure A-1. The producer will switch oil for gas but by a different degree than at point 2. The producer has increased gas consumption by the amount AD. Oil consumption has fallen more and gas consumption is less than at point 2 because output is lower. Output in this case is the same and costs are lower. The relative prices at point 2 equal those at point 4.

In the WAIFM simulations, the input-output coefficients were changed to match point 4 gas consumption. Output was assumed to be the same as the pre-adjustment level (point 3). The gas coefficients were increased and oil coefficients were decreased (in Figure A-1 the two coefficients are combined). Point 4 is only a first estimate. The lower costs to the firm may end up as higher profits or wages or lower end product prices. If all firms are faced with the same situation as this firm, then income and output may increase and the final equilibrium will be at point 2. Indeed, that is exactly what the results of the simulation showed. Output increased in those sectors that had their input-output coefficients changed.

FIGURE A-1


OIL
GAS
O
A
D
C
B
1
2
3
4
5
Q^*
Q^1
Q^0
$\frac{P_G^3}{P_O}$
$\frac{P_G^2}{P_O}$
$\frac{P_G^1}{P_O}$

FIRM PRODUCTION FUNCTION

As noted above, the estimation procedure in WAIFM could not approximate this change in gas use. The model assumes that point 3 is an efficient point (the ratio of the marginal products of the inputs equals the ratio of the prices of the inputs). Increased gas prices shift the isocost line in and WAIFM would predict some point such as point 5 as the new equilibrium. The above computations confirm this thesis. Gas consumption falls between the scenarios and oil consumption by industry increases. The input-output coefficients were changed to correct this problem.

The increases in gas use required to match WAIFM to GMES are given in Table A-37.

Coefficient changes were calculated by first determining the total Btu refined petroleum use for industrial and commercial sectors. The refined petroleum use by industrial and commercial sectors is given in Table A-38.

The changes listed in Table A-38 were converted to Btu's by multiplying 1.024 MMBtu/mcf. The Btu changes were then divided by total Btu fuel use to calculate the percentage decrease of refined petroleum use in Btu's that was displaced by natural gas. These percentages are listed in Table A-39.

Petroleum use by each industrial sector was changed by the percentages in the industrial column. Each commercial sector's petroleum use was changed by the percentage listed in the commercial column.

The percentage changes listed in Table A-39 are the total changes required. Estimates of individual sector changes, however, were needed so that each coefficient could be altered.

In WAIFM nomenclature, the changes for 1982 would be calculated as:

$$\Delta XMQ\&PU = XMQ\&PU * .12223 \tag{4}$$

and

$$\Delta XMQ\&PU = XMQ\&PU * .00095 \tag{5}$$

where:

$\Delta XMQ\&PU$ = Change in petroleum use in Quadrillion Btu's by sector &

$XMQ\&PU$ = Original petroleum use in Quadrillion Btu's by sector &

where & = for each industrial and commercial sector.

TABLE A-37

NATURAL GAS USE INCREASE REQUIRED TO EQUALIZE WAIFM WITH GMES
(BCF)

Year	Industrial	Commercial
1982	676.7	11.0
1983	898.9	193.1
1984	964.9	301.5
1985	451.9	326.9
1986	198.6	191.7
1987	-26.9	65.1
1988	-23.1	1.4
1989	-139.8	-6.4
1990	-183.8	2.3

TABLE A-38

REFINED PETROLEUM USE - WAIFM - REFFUL82
(Quadrillion Btu's)

Year	Industrial	Commercial
1982	5.669	11.861
1983	5.808	12.085
1984	5.972	12.616
1985	6.082	13.063
1986	6.186	13.411
1987	6.351	13.914
1988	6.511	14.431
1989	6.642	14.943
1990	6.780	14.435

TABLE A-39

PERCENTAGE OF REFINED PETROLEUM USE SWITCHED TO NATURAL GAS
(Percent)

Year	Industrial	Commercial
1982	12.223	0.095
1983	15.847	1.636
1984	16.546	2.448
1985	7.608	2.563
1986	3.299	1.464
1987	-0.434	0.479
1988	-0.363	0.010
1989	-2.156	-0.044
1990	-2.776	-0.022

WAIFM input-output coefficients are in 1972 dollars, so the Btu changes must be converted to 1972 dollars changes by multiplying by the 1972 price per Btu for petroleum and gas.

$$\Delta XMP\&P = \Delta XMQ\&PU * 1.06497 \qquad (6)$$

and

$$\Delta XMP\&G = \Delta XMQ\&PU * 0.73 \qquad (7)$$

where:

$\Delta XMP\&P$ = Change in petroleum use in 1972 dollars by sector &

$\Delta XMP\&G$ = Change in gas use in 1972 dollars by sector &

1.06497 = 1972 price/MMBtu for refined petroleum

0.73 = 1972 price/MMBtu for natural gas

The input-output coefficient changes are calculated by dividing by the gross outputs.

$$\Delta AP\& = \Delta XMP\&P/XGG\& \qquad (8)$$

$$\Delta AG\& = \Delta XMP\&G/XGG\& \qquad (9)$$

where

$\Delta AP\&$ = Input-output coefficient for petroleum use by sector &

$\Delta AG\&$ = Input-output coefficient for gas use by sector &

$XGG\&$ = Gross output of sector &.

The above changes were introduced by rewriting the matrix of I-O coefficients that was produced in the naive simulation.

2. Energy to Value Added

An additional adjustment is required to balance the matrix (i.e., make the columns sum to 1.0). The ratios of energy to value added must change to reflect the input-output coefficient changes. These changes are calculated as follows:

$$\Delta RAXMP\& = (\Delta AP\& + \Delta AG\&) * RAXMN{+}P\& \qquad (10)$$

where

$\Delta RAXMP\&$ = Change in energy to value added ratio for sector &

$RAXMN{+}P\&$ = Ratio of gross output to value added in sector &.

3. Gas Import Adjustment

Gas imports will change as a result of the above changes, so an additional add factor is required to equalize imports of gas in the two scenarios. The final add factor used was:

	1982	1983	1984	1985	1986	1987	1988	1989	1990
DECR TMQTGT34	.2105	-.0837	.1491	.2046	.0946	.2529	.3521	.9888	1.4214

The GNP and price results of excluding the efficiency gains in the simulations are given in Tables A-40 and A-41.

Inclusion of the efficiency gains reduced GNP losses from accelerated decontrol by approximately 17%. Real GNP losses in 1982-84 are reduced from $23.1 billion in the naive case to $15.6 in the standard case. Over the entire decade real GNP losses drop from $21.2 billion to $13.6 billion. As discussed above, inflation will

TABLE A-40

REAL GROSS NATIONAL PRODUCT
(Billion 1972 Dollars)

Year	REFCUR85	REFFUL82NA	Difference	% Difference
1981	1,512.9	1,512.9	0.0	0.0
1982	1,556.0	1,548.0	-8.0	-0.5
1983	1,614.9	1,606.4	-8.5	-0.5
1984	1,685.4	1,678.7	-6.7	-0.4
1985	1,728.3	1,782.5	4.2	0.2
1986	1,788.1	1,782.5	-5.6	-0.3
1987	1,837.4	1,839.5	2.1	0.1
1988	1,895.4	1,899.0	3.5	0.2
1989	1,956.8	1,958.5	1.7	0.1
1990	2,025.0	2,021.6	-3.9	-0.2

TABLE A-41

IMPLICIT GROSS NATIONAL PRODUCT DEFLATOR
(1972 = 100)

Year	REFCUR85	REFFUL82NA	Difference	% Difference
1981	193.3	193.3	0.0	0.0
1982	209.2	214.2	5.0	2.4
1983	225.4	231.8	6.4	2.8
1984	248.1	250.7	7.6	3.1
1985	266.5	269.8	3.3	1.2
1986	286.4	288.4	2.0	0.7
1987	306.8	307.9	1.1	0.4
1988	327.9	328.9	1.0	0.3
1989	350.8	351.1	0.3	0.1
1990	375.1	375.6	0.5	0.1

REFCUR85 = NGPA decontrol in 1985

REFFUL82NA = Accelerated decontrol - no I-O adjustment (Naive) tend to be reduced with improved efficiency. The simulations reinforce this hypothesis. The GNP deflator increase due to accelerated decontrol increases from 2.3% to 2.4% in 1982. In 1983, the increase is from 2.7% to 2.8%.

Efficiency gains are quantified in Tables A-42 and A-43. The naive and standard cases for the full accelerated are listed. The efficiency gains are the difference between the two cases. The gains average $.8 billion per year and sum to $7.0 billion in the entire decade.

Table A-43 lists the price effects due to improvements in efficiency. In the earlier years, price increases are dampened because of improved efficiency. The reason for this decline is that producers' energy costs have fallen. Output rises, productivity increases and costs fall somewhat. Downward price pressure continues throughout the decade.

B. REFFUL82GOV - Government Spending Increase

In order to offset the reduction in purchasing power resulting from the increased corporate tax collections, government defense and non-defense expenditures were increased by the amount of increased federal government surplus and a third simulation was performed. The increase in the federal government surplus ΔGVSURPF$ in the REFFUL82STD case was:

	1982	1983	1984	1985	1986	1987	1988	1989	1990
ΔGVSURPF$	17.856	14.481	17.967	8.789	4.502	13.459	19.785	15.687	16.836

These values were converted to 1972 dollars using the GNP deflator.

	1982	1983	1984	1985	1986	1987	1988	1989	1990
PDGNP	214.1	231.5	250.2	269.3	288.0	307.6	328.7	350.9	375.4

The 1972 dollar increase was:

	1982	1983	1984	1985	1986	1987	1988	1989	1990
ΔGVSURPF	8.340	6.255	7.181	3.264	1.563	4.375	6.019	4.471	3.153

TABLE A-42

REAL GROSS NATIONAL PRODUCT
(Billion 1972 Dollars)

Year	REFFUL82NA	REFFUL82	Difference	% Difference
1981	1,512.9	1,512.9	0.0	0.0
1982	1,548.0	1,549.4	1.3	0.1
1983	1,606.4	1,609.2	2.8	0.2
1984	1,678.7	1,682.1	3.4	0.2
1985	1,732.5	1,735.2	2.7	0.2
1986	1,782.5	1,783.6	1.1	0.1
1987	1,839.5	1,839.2	-0.3	-0.0
1988	1,899.0	1,897.8	-1.1	-0.1
1989	1,958.5	1,957.0	-1.6	-0.1
1990	2,021.6	2,020.4	-1.2	-0.1

TABLE A-43

IMPLICIT GROSS NATIONAL PRODUCT DEFLATOR
(1972 = 100)

Year	REFFUL82NA	REFFUL82	Difference	% Difference
1981	198.3	193.3	0.0	0.0
1982	214.2	214.1	-0.1	-0.1
1983	231.8	231.5	-0.3	-0.1
1984	250.7	250.2	-0.5	-0.2
1985	269.8	269.3	-0.5	-0.2
1986	288.4	288.0	-0.4	-0.1
1987	307.9	307.6	-0.3	-0.1
1988	328.9	328.7	-0.2	-0.1
1989	351.1	350.9	-0.2	-0.0
1990	375.6	375.4	-0.1	-0.0

REFFUL82 - Accelerated decontrol - including I-O adjustment (Standard)

REFFUL82NA - Accelerated decontrol - no I-O adjustment (Naive)

These values were divided equally between defense and non-defense spending and the following add factors applied:

	1982	1983	1984	1985	1986	1987	1988	1989	1990
Defense Spending Increase INCR GVPFD	4.170	3.128	3.591	1.632	.782	2.188	3.010	2.235	1.576

	1982	1983	1984	1985	1986	1987	1988	1989	1990
Non-Defense Increase INCR GVPFO	4.170	3.128	3.591	1.632	.782	2.188	3.010	2.235	1.576

The changes were applied to the Standard Case described above.

C. REFFUL82PTX - Personal Tax Cut

A fourth simulation was performed in which personal taxes were cut by the amount of increased corporate taxes in the Standard Case. The following add factor was used:

	1982	1983	1984	1985	1986	1987	1988	1989	1990
DECR TXCPF$	17.856	14.481	17.967	8.789	4.502	13.459	19.785	15.786	11.836

UNITED STATES
DEPARTMENT OF ENERGY
WASHINGTON, D.C. 20585

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF ENERGY
DOE 350

U.S.MAIL